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FINAL SAMPLING AND ANALYSIS PLAN FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN AND GROUNDWATER INVESTIGATION FEASIBILITY STUDY ADDENDUM OPERABLE UNIT 19 SITE 44 SEPTEMBER 2012 NAS PENSACOLA FL
09/01/2012
TETRA TECH INC

Comprehensive Long-term Environmental Action Navy

CONTRACT NUMBER N62467-04-D-0055

Rev. 4
September 2012

Final
Sampling and Analysis Plan
(Field Sampling Plan and Quality Assurance Project Plan)

Groundwater Investigation
for
Operable Unit 19 - Site 44
Feasibility Study Addendum

Naval Air Station Pensacola
Pensacola, Florida

Contract Task Order 0079

September 2012

NAVFAC
Naval Facilities Engineering Command
NAVFAC SOUTHEAST
NAS Jacksonville
Jacksonville, Florida 32212-0030

TETRA TECH

SAP Worksheet No. 1 -- Title and Approval Page
(UFP-QAPP Manual Section 2.1)

FINAL
SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)

GROUNDWATER INVESTIGATION WORK PLAN
FOR
OPERABLE UNIT 19 (SITE 44)
FEASIBILITY STUDY ADDENDUM

September 2012

Naval Air Station Pensacola
Pensacola, Florida
USEPA ID FL9170024567

Prepared for:
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EXECUTIVE SUMMARY

This Sampling and Analysis Plan (SAP) encompasses the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) requirements for the Groundwater Investigation Plan for Site 44 [Operable Unit (OU) 19] Feasibility Study (FS) Addendum, at Naval Air Station (NAS) Pensacola, Florida. This SAP and the accompanying Health and Safety Plan (HASP) constitute the Work Plan for Groundwater Investigation for Site 44 FS Addendum. This SAP/Work Plan (hereafter called SAP), is the primary planning document, addressing data quality objectives, specific protocols for sample collection, sample handling and storage, chain-of-custody, laboratory and field analyses, data validation, and data reporting. This SAP was prepared to provide three quarterly groundwater sampling events and additional groundwater data to update the conceptual site model and related FS at Site 44.

This SAP has been prepared by Tetra Tech, Inc. on behalf of Naval Facilities Engineering Command Southeast (NAVFAC SE) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62467-04-D-0055, Contract Task Order (CTO) 0079. This SAP was generated for and complies with applicable United States Navy, the United States Environmental Protection Agency (USEPA), and the Florida Department of Environmental Protection (FDEP) requirements, regulations, guidance, and technical standards. This includes the Department of Defense (DoD), Department of Energy (DOE), and USEPA Intergovernmental Data Quality Task Force (IDQTF) environmental requirements regarding federal facilities. To comply with IDQTF requirements, this SAP is presented in the format of standard worksheets as specified in the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) guidance document (IDQTF, 2005). Environmental assessment and remedial activities at NAS Pensacola are being conducted under the Comprehensive Environmental Response, Compensation and Liability Act (also known as Superfund). The USEPA assigned identification number for NAS Pensacola is FL9170024567.

NAS Pensacola is located in Escambia County, Florida. Figure ES-1 presents a facility location map depicting the location of Site 44 on the installation. Site 44 is located in the central portion of NAS Pensacola at the southwestern end of Building 3221. Building 3221 is used by National Museum of Naval Aviation staff to refurbish aircraft. Building 3221 is a large hangar adjacent to Forrest Sherman Field, which was opened in 1955 as the master jet landing field for NAS Pensacola. In 1983, Building 3221 was shown as part of the Naval Air Rework Facility (NARF), formerly the NAS Pensacola operations and repair department and was likely used for aircraft maintenance before the current National Museum of Naval Aviation location opened in 1975. The past and current use of the paved area adjacent to the southwest corner of Building 3221 is a wash rack for cleaning aircraft and aircraft parts. According to

National Museum of Naval Aviation personnel, only biodegradable surfactant agents are used by the National Museum of Naval Aviation to clean parts.

Site 44 includes approximately 2.16 acres and the surface cover for the site is primarily 18-inch thick concrete pavement with adjacent areas that have grass, asphalt, or tree cover. The area at the southwest corner of Building 3221 was the former location of a 1,000-gallon underground storage tank (UST) that was installed in 1967 and reportedly used to store PD-680 (a petroleum distillate cleaning solvent, also known as Stoddard Solvent). The UST was removed in 1989-1990 and replaced with a new 500-gallon UST used to store waste oil (ABB-ES, 1993). The new 500-gallon UST likely stored waste oil generated from aircraft maintenance operations historically performed at Building 3221. This 500-gallon waste oil tank was subsequently removed on May 2, 1994 (Navy, 1994). There are no USTs remaining at the site.

Based on previous investigations at the site, including information provided in the UST Site 3221SW Contamination Assessment Report (CAR) (ABB-ES, 1993) and the Remedial Investigation (RI) Report for Site 44 (Former UST Site 3221SW) (Tetra Tech, 2008), chemicals of concern (COCs) in groundwater include trichloroethene (TCE) and related biodegradation products at relatively low concentrations primarily in the shallow aquifer zone. The previous investigations, including soil and groundwater data collected in the vicinity of the former UST 3221SW, the wash rack area, and the southwestern end of Building 3221 adjacent to the wash rack area, did not identify a source of the chlorinated solvents detected in groundwater. However, the resulting conceptual site model and current hypothesis for the source is that dilute concentrations of chlorinated solvents may have seeped through the concrete pavement construction joints during historical wash rack operations.

An FS report evaluating remedial alternatives was issued in April 2010 (Tetra Tech). The subsequent Proposed Plan (June 2010) recommended Monitored Natural Attenuation (MNA) as the groundwater remedy. However, the Proposed Plan was not accepted by the USEPA, which concluded sufficient lines of evidence had not been provided during previous investigations to support the efficacy of MNA as a timely remedy for the site.

To provide additional lines of evidence that may support the efficacy of an MNA remedy and to compare MNA with other remedial alternatives being considered, additional groundwater data will be collected at the site during three quarterly sampling events to provide spatial and temporal contaminant trend information, geochemistry, and potentially molecular biological and related compound specific isotope analysis (CSIA) information. The molecular biological and CSIA information will be collected only during the third sampling event if, based on their review of the first two sampling events, the NAS Pensacola Partnering Team decides such additional lines of evidence are necessary to support the efficacy of MNA.

The additional information will include sampling existing monitoring wells and new monitoring wells that are to be installed in four locations to assess conceptual site model data gaps of the vertical distribution of groundwater contamination. The additional information is intended to be used to develop an FS Addendum to reevaluate MNA and the other remedial alternatives and subsequently revise the Proposed Plan as appropriate.

The Team held a Data Quality Objective (DQO) meeting on April 28, 2011 to develop a scope for the Uniform Federal Policy Sampling and Analysis Plan (UFP-SAP). Among other details, the Team agreed that the focus of the additional investigation and monitoring was to support an FS Addendum by collecting additional data to adequately assess the proposed MNA remedy with sufficient lines of evidence and to further compare MNA and other remedial alternatives. During the DQO Meeting, the Team initially agreed to use the “Tier II” UFP-SAP format to expedite the UFP-SAP development. The content of the Tier II format was provided to USEPA and preliminary worksheets in the Tier II format were provided for regulatory review. After USEPA indicated that the Tier II format was acceptable, the Navy prepared and submitted (July 28, 2011) the Draft UFP-SAP in the Tier II format. However, USEPA’s comments (September 23, 2011) on the Draft Tier II UFP-SAP indicated neither USEPA Region 4 nor USEPA headquarters has yet approved the Tier II format and that the Navy would be required to revise the Tier II UFP-SAP to the original Tier 1 UFP-SAP format to provide worksheet information consistent with the federal agencies approved Tier 1 format. The Navy agreed (November 1, 2011) to revise the UFP-SAP to the Tier 1 UFP-SAP to expedite the approval process.

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ACRONYMS AND ABBREVIATIONS

^{o}C	Degrees Celsius
%D	Percent Difference (Drift)
%R	Percent Recovery
%RSD	Percent Relative Standard Deviation
ABB-ES	ABB Environmental Services, Inc.
AS	Air Sparging
ASTM	American Society for Testing and Materials
BEHP	Bis(2-ethylhexyl)phthalate
BFB	Bromofluorobenzene
bls	Below Land Surface
BOD	Biochemical Oxygen Demand
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CA	Corrective Action
CAR	Contamination Assessment Report
CAS	Chemical Abstracts Service
CCC	Calibration Check Compound
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
CLP-SOW	Contract Laboratory Program-Statement of Work
COC	Chemical of Concern
COD	Chemical Oxygen Demand
COPC	Contaminant of Potential Concern
cPAH	Carcinogenic Polycyclic Aromatic Halocarbon
Cr^{6}	Hexavalent Chromium
CSIA	Compound Specific Isotope Analysis
CSM	Conceptual Site Model
CTL	Cleanup Target Level
CTO	Contract Task Order
cVOC	Chlorinated Volatile Organic Compound
cVOH	Chlorinated Volatile Organic Hydrocarbon

ACRONYMS AND ABBREVIATIONS (CONTINUED)

DCA	Dichloroethane
DCE	Dichloroethene
DI	Deionized
DL	Detection Limit
DO	Dissolved Oxygen
DoD	Department of Defense
DOE	Department of Energy
DPT	Direct Push Technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
DVM	Data Validation Manager
EDD	Electronic Data Deliverable
ELAP	Environmental Laboratory Accreditation Program
Empirical	Empirical Laboratories, LLC
Ext.	Extension
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FID	Flame Ionization Detector
FOL	Field Operations Leader
FS	Feasibility Study
FSP	Field Sampling Plan
FTMR	Field Task Modification Request
g	Gram
GC/FID	Gas Chromatography/ Flame Ionization Detector
GC/MS	Gas Chromatograph/ Mass Spectrometer
GC/IRMS	Gas Chromatograph/Isotopic Ratio Mass Spectrometer
GCTL	Groundwater Cleanup Target Level
GPS	Geographical Positioning System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	Hydrochloric Acid
HHRA	Human Health Risk Assessment
HNO_3	Nitric Acid

ACRONYMS AND ABBREVIATIONS (CONTINUED)

HSM	Health and Safety Manager
H_2SO_4	Sulfuric Acid
IC	Ion Chromatography
ICAL	Initial Calibration
ICP-AES	Inductively Coupled Plasma - Atomic Emission Spectroscopy
IDQTF	Intergovernmental Data Quality Task Force
ICV	Initial Calibration Verification
IDW	Investigation-Derived Waste
IR	Installation Restoration
IS	Internal Standard
L	Liter
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
LNAPL	Light Non-Aqueous Phase Liquid
LOD	Limit of Detection
LOQ	Limit of Quantitation
LUC	Land Use Control
MBT	Molecular Biological Tool
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mL	Milliliter
Microseeps	Microseeps, Inc.
MNA	Monitored Natural Attenuation
MPC	Measurement Performance Criterion
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Applicable/Not Available
NARF	Naval Air Rework Facility
NCP	National Contingency Plan
NAS	Naval Air Station
NASP Env.	Naval Air Station Pensacola Environmental

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NAD	North American Datum
NAVFAC SE	Naval Facilities Engineering Command Southeast
NEDD	NIRIS Electronic Data Deliverable
NEESA	Naval Energy and Environmental Support Activity
NELAP	National Environmental Laboratory Accreditation Program
NFA	No Further Action
NIRIS	Naval Installation Restoration Information Solution
NNAM	National Naval Aviation Museum
NTU	Nephelometric Turbidity Unit
ORP	Oxidation Reduction Potential
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
OVA	Organic Vapor Analyzer
oz	ounce
PA	Preliminary Assessment
PAL	Project Action Limit
PCE	Tetrachloroethene
PAH	Polycyclic Aromatic Hydrocarbon
PAL	Project Action Limit
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PLFA	Phospholipid Fatty Acid
PM	Project Manager
POC	Point of Contact
ppb	parts per billion
ppm	parts per million
PQLG	Practical Quantitation Limit Goal
PQO	Project Quality Objective
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QSM	Quality Systems Manual for Environmental Laboratories

ACRONYMS AND ABBREVIATIONS (CONTINUED)

QAO	Quality Assurance Officer
QC	Quality Control
qPCR	quantitative Polymerase Chain Reaction
RAO	Remedial Action Objective
RF	Response Factor
RI	Remedial Investigation
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RRT	Relative Retention Time
RSD	Relative Standard Deviation
RSL	Regional Screening Level
RT	Retention Time
SAP	Sampling and Analysis Plan
SCTL	Soil Cleanup Target Level
SDG	Sample Delivery Group
SDWA	Safe Drinking Water Act
SESD	Science and Ecosystem Support Division
SI	Site Investigation
SIP	Stable Isotope Probing
SM	Standard Method
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	System Performance Check Compound
SPCS	State Plane Coordinate System
SPLP	Synthetic Precipitation Leaching Procedure
SSO	Site Safety Officer
SVE	Soil Vapor Extraction
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TBD	To Be Determined
TCA	Trichloroethane
TCE	Trichloroethene

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TCL	Target Compound List
TIC	Tentatively Identified Compounds
TRPH	Total Recoverable Petroleum Hydrocarbons
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
UFP-SAP	Uniform Federal Policy Sampling and Analysis Plan
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VC	Vinyl Chloride
VOC	Volatile Organic Compound
WWTP	Wastewater Treatment Plant

SAP Worksheet No. 2 -- SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number:	Site 44
Operable Units:	Operable Unit (OU) 19
Contractor Name:	Tetra Tech, Inc.
Contract Number:	N62467-04-D-0055
Contract Title:	Comprehensive Long-Term Environmental Action Navy (CLEAN)
Work Assignment Number:	Contract Task Order (CTO) 0079

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the Intergovernmental Data Quality Task Force (IDQTF) document, *Uniform Federal Policy for Quality Assurance Plans* (UFP-QAPP) (IDQTF, 2005) and the United States Environmental Protection Agency (USEPA) document, *Guidance for Quality Assurance Project Plans, QA/G-5* (USEPA, 2002).

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Florida Department of Environmental Protection (FDEP) Contaminated Site Cleanup Criteria, Chapter 62-780, Florida Administrative Code. (F.A.C.)

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Site Visit/Meeting	November 29, 2010
Data Quality Objective (DQO) Meeting	April 28, 2011

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
Sampling and Analysis Plan For Site Characterization at Installation Restoration Site 44 (Former UST Site 3221 SW) Naval Air Station Pensacola, Pensacola, Florida	June 2005

6. List organizational partners (stakeholders) and connection with lead organization:

U.S. Naval Station Pensacola (Property Owner), Naval Facilities Engineering Command Southeast (NAVFAC SE) (Lead Organization), USEPA and FDEP (Regulatory Oversight), Tetra Tech (Navy Contractor)

7. Lead organization: NAVFAC SE (property owner)

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

Not Applicable (NA), as there are no exclusions.

SAP Worksheet No. 3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipients	Title/Role	Organization and Mailing Address	Telephone Number	E-Mail Address
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TBD (electronic copy only)	Well Installation Subcontractor PM/ Provides Drilling Services	TBD	TBD	TBD
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Each person in this table will be responsible for distributing copies of this SAP to appropriate personnel within their organization. For example, the Tetra Tech PM will be responsible for distributing copies of this SAP to all Tetra Tech personnel listed in Worksheet No. 4 (Project Personnel Sign-Off Sheet).

SAP Worksheet No. 4 -- Project Personnel Sign-Off Sheet

(UFP-QAPP Manual Section 2.3.2)

Certification that project personnel have read the text will be obtained by one of the following methods as applicable:

1. In the case of regulatory agency personnel with oversight authority, approval letters or e-mails will constitute verification that applicable sections of the SAP have been reviewed. Copies of regulatory agency approval letters / e-mails will be retained in the project files and are listed in Worksheet No. 29 as project records.

2. E-mails will be sent to the Navy, Tetra Tech, and subcontractor project personnel whom will be requested to verify by e-mail that they have read the applicable SAP / sections and the date on which they were reviewed. Copies of the verification e-mail will be included in the project files and are identified in Worksheet No. 29.

   Copies of the signed Worksheets No. 1 and 4 will be retained in the project files and are identified as a project documents in Worksheet No. 29.

Name (1)	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Navy and Regulator Project Team Personnel					
Patty Whittemore	Navy Remedial RPM/ Manages Project Activities for the Navy	904-542-6202	See Worksheet No. 1 for signature	All	
Greg Campbell	NAS Pensacola POC - Site Manager/ Manages Daily Site Activities Related to this Project	(850)452-3131 Ext. 3007	See Worksheet No. 1 for signature	All	
Ken Bowers	NAVFAC QAO/ Navy Chemist	757-322-8341	See Worksheet No. 1 for signature	All	
Tim Woolheater	USEPA RPM/ Manages Project	(404) 562-8510	See Worksheet No. 1 for signature	All	
David Grabka	FDEP RPM/ Manages Project	(850)245-8997	See Worksheet No. 1 for signature	All	

Name [1]	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
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Tetra Tech Project Team Personnel					
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Amber Igoe	Tetra Tech/ FOL/SSO/ Manages Field Operation and Site Safety Issues	(850)385-9866 Ext. 1352		All	
Kelly Carper	Tetra Tech/ QAM/ Manages Corporate QA Program and Implementation	(412)921-7273	See Worksheet No. 1 for signature	All	
Matt Soltis	Tetra Tech/ HSM/ Manages Corporate Health and Safety Program	(412)921-8912	See HASP for signature	HASP	
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Joe Samchuck	Tetra Tech/ DVM/ Manages data validation	(412)921-8510		Worksheets No. 12, 14, 15, 19, 20, 23-28, 30, and 34-37	
Subcontractor Personnel					
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Brian Richard (electronic copy only)	Empirical Laboratory PM/ Representative for Laboratory and Analytical Issues	(615)345-1115		Worksheets No. 6, 12, 14, 15, 19, 23-28, 30, and 34-36	

Name [1]	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
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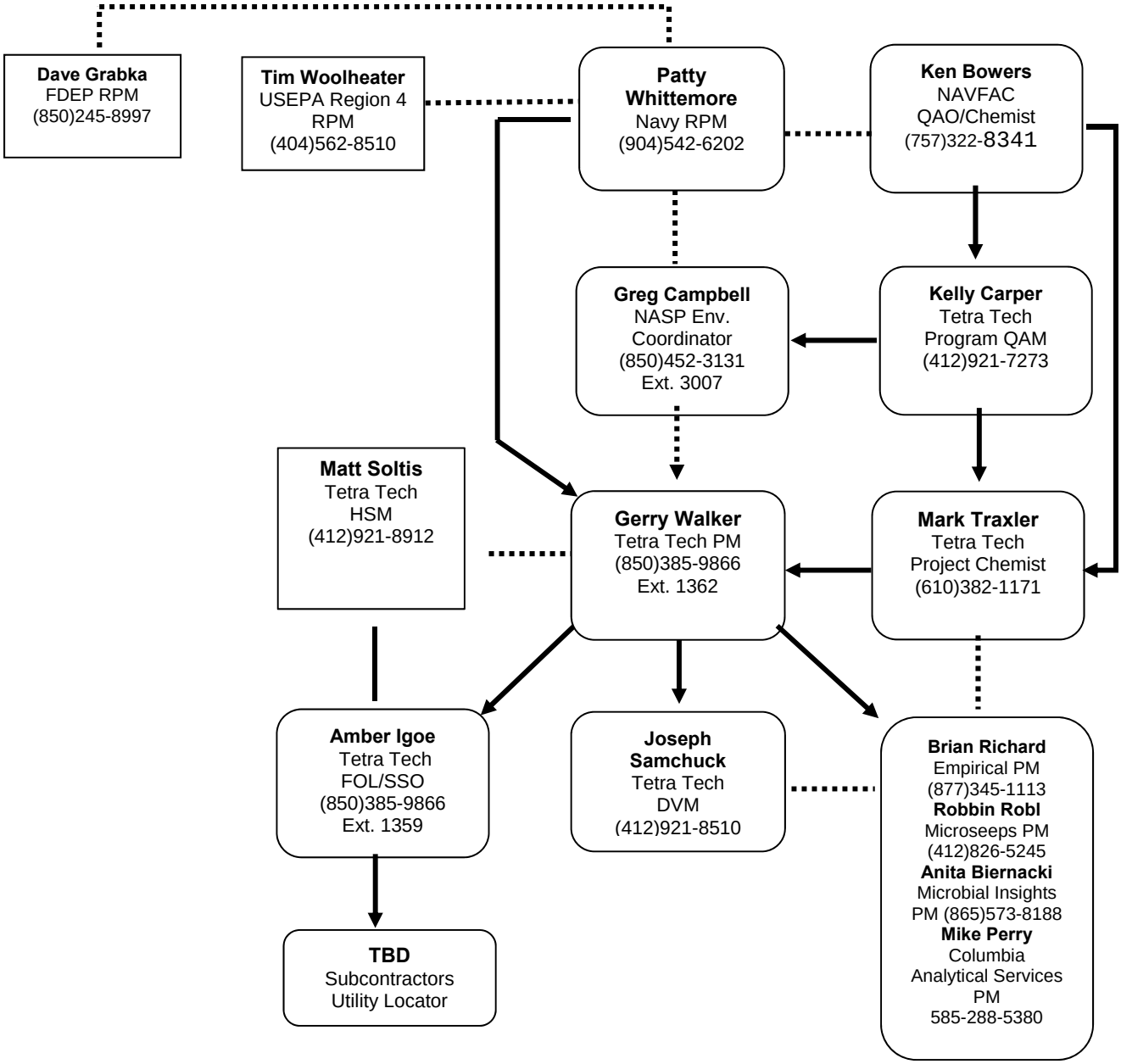
1 Persons listed on this worksheet will be responsible for distributing the SAP to the appropriate people within their organization.

SAP Worksheet No. 5 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)

Lines of Authority

Lines of Communication



SAP Worksheet No. 6 -- Communication Pathways

(UFP-QAPP Manual Section 2.4.2)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Gaining Site Access	Tetra Tech FOL NASP Env. Coordinator	Amber Igoe Greg Campbell	(850)385-9866 Ext. 1352 (850)452-3131 Ext. 3007	The Tetra Tech FOL shall contact the NASP Env. Coordinator verbally or via e-mail at least three days prior to commencement of field work to arrange for access to the site for all field personnel.
Work Plan amendments	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM USEPA RPM	Amber Igoe Gerry Walker Patty Whittemore Tim Woolheater	(850)385-9866 Ext. 1352 (850)385-9866 Ext. 1362 (904)542-6202 (404) 562-8510	The Tetra Tech FOL will verbally inform the Tetra Tech PM within 24 hours of realizing a need for an amendment. The Tetra Tech PM will document the proposed changes via a Field Task Modification Request (FTMR) form within five days and send the Navy RPM a concurrence letter within seven days of identifying the need for change. Work Plan amendments will be submitted by the Tetra Tech PM to the Navy RPM for review and approval. The Tetra Tech PM will send scope changes to the Project Team via e-mail within one business day.
Schedule changes	Tetra Tech PM Navy RPM NASP Env. Coordinator	Gerry Walker Patty Whittemore Greg Campbell	(850)385-9866 Ext. 1362 (904)542-6202 (850)452-3131 Ext. 3007	The Tetra Tech PM will send Navy RPM and NASP Env. Coordinator and USEPA RPM a schedule concurrence letter within 7 days or realizing a schedule impact or prior to the first affected deliverable date.

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Field issues that require changes in scope or implementation of field work	Tetra Tech FOL Tetra Tech PM Navy RPM USEPA RPM	Amber Igoe Gerry Walker Patty Whittemore Tim Woolheater	(850)385-9866 Ext. 1352 (850)385-9866 Ext. 1362 (904)542-6202 (404) 562-8510	The Tetra Tech FOL will verbally inform the Tetra Tech PM on the day the issue is discovered. The Tetra Tech PM will inform the Navy RPM and the NASP Env. Coordinator (verbally or by e-mail) of the issue within one day of the discovery. The Navy RPM will issue scope change (verbally or via e-mail), if warranted. The scope change is to be implemented before further work is executed. The Tetra Tech PM will also send a concurrence letter to the Navy RPM within seven days, if project scope is affected. The Navy RPM will sign the letter within five days of receipt. The Tetra Tech PM will document the change(s) via an FTMR form within two days of identifying the need for change and will obtain required approvals within five days of initiating the form.
Stop work recommendations, for example, to protect workers from unsafe conditions/ situations or to prevent a degradation in quality of work/ and initiate work upon corrective action	Tetra Tech FOL/SSO Tetra Tech PM Tetra Tech QAM Navy RPM NASP Env. Coordinator	Amber Igoe Gerry Walker Kelly Carper Patty Whittemore Greg Campbell	(850)385-9866 Ext. 1352 (850)385-9866 Ext. 1362 (412)921-7372 (904)542-6202 (850)452-3131 Ext. 3007	If Tetra Tech is the responsible party for a stop work command, the Tetra Tech FOL will inform on-site personnel, subcontractor(s), the NASP Env. Coordinator, and the identified Project Team members within one hour (verbally or by e-mail). If a subcontractor is the responsible party, the subcontractor PM must inform the Tetra Tech FOL within 15 minutes, and the Tetra Tech FOL will then follow the procedure listed above.

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Corrective action for field program	Tetra Tech QAM Tetra Tech PM	Kelly Carper Gerry Walker	(412)921-7273 (850)385-9866 Ext. 1362	The Tetra Tech QAM will notify the Tetra Tech PM verbally or by e-mail within one business day that the corrective action has been completed. The Tetra Tech PM will then notify the Navy and USEPA RPMs and within one business day.
Field data quality issues	Tetra Tech FOL/SSO Tetra Tech PM	Amber Igoe Gerry Walker	(850)385-9866 Ext. 1352 (850)385-9866 Ext. 1362	The Tetra Tech FOL will inform the Tetra Tech PM verbally or by e-mail on the same day that a field data quality issue is discovered.

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Laboratory data quality issues	Laboratory PM Tetra Tech Project Chemist Tetra Tech DVM Tetra Tech PM Navy RPM USEPA RPM	Brian Richards Mark Traxler Joseph Samchuck Gerry Walker Patty Whittemore Tim Woolheater	(877) 345-1113 ext. 249 (610) 382-1171 (412) 921-8510 (850)385-9866 Ext. 1362 (904)542-6202 (404) 562-8510	The Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within one business day of when an issue related to laboratory data is discovered. The Tetra Tech Project Chemist will notify (verbally or via e-mail) the data validation staff and the Tetra Tech PM within one business day. Tetra Tech DVM or Project Chemist notifies Tetra Tech PM 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. The Tetra Tech PM verbally advises the Navy RPM within 24 hours of notification from the project chemist or DVM. The Navy RPM takes corrective action that is appropriate for the identified deficiency. Examples of significant laboratory deficiencies include data reported that has a corresponding failed tune or initial calibration verification. Corrective actions may include a consult with the NAVFAC Navy Chemist.
Obtaining Utility Clearances	Tetra Tech FOL	Amber Igoe	IRBY (850) 452-5524 Sunshine One Call 811	The Tetra Tech FOL shall contact the IRBY Engineering Inc. and Sunshine State One Call verbally or via e-mail at least 14 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation.

SAP Worksheet No. 7 -- Personnel Responsibilities and Qualifications Table

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Patty Whittemore	RPM/Manages project	NAVFAC SE	Oversees project implementation, including scoping, data review, and evaluation.
Greg Campbell	NASP Env. Coordinator/Manages daily site activities related to this project	NAS Pensacola	Oversees site activities and participates in scoping, data review, evaluation, and reviews the SAP.
Dave Grabka	RPM / Provides Regulator Input	FDEP	Participates in scoping, conducts data review and evaluation, and approves the SAP on behalf of IDEM.
Tim Woolheater	RPM / Provides Regulator Input	EPA Region 4	Participates in scoping, conducts data review and evaluation, and approves the SAP on behalf of USEPA.
Gerry Walker	PM / Manages project on a daily basis	Tetra Tech	Oversees project, financial, schedule, and technical day-to-day management of the project.
Amber Igoe	FOL/SSO/ Manages field operations and oversees site activities to ensure safety requirements are met	Tetra Tech	As FOL, supervises, coordinates, and performs field sampling activities. As the SSO, is responsible for on-site project-specific health and safety training and monitoring site conditions. The FOL verifies that the appropriate equipment and materials to conduct the investigation are on-site. Details of health and safety responsibilities are presented in the Health and Safety Plan (HASP).
Kelly Carper	QAM/ Oversees program and project QA activities	Tetra Tech	Ensures that quality aspects of the CLEAN Program are implemented.
Matt Soltis	HSM/ Oversees health and safety activities	Tetra Tech	Oversees the Tetra Tech CLEAN Program Health and Safety Program.
Mark Traxler	Project Chemist/ Conducts project oversight of data validation and reporting	Tetra Tech	Participates in project scoping, prepares laboratory scopes of work, and coordinates laboratory-related functions with laboratory. Oversees data quality reviews and QA of data validation deliverables.
Joseph Samchuck	DVM / Oversees data validation activities	Tetra Tech	Manages data validation activities within Tetra Tech, including ensuring QA of data validation deliverables, providing technical advice on data usability, and coordinating and maintaining the data validation review schedule.

Name	Title/Role	Organizational Affiliation	Responsibilities
Brian Richard	Laboratory PM/ Manages project	Empirical	Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides QA of data packages, and communicates with Tetra Tech project staff.
Mike Perry	Laboratory PM/ Manages project	Columbia Analytical Services	Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides QA of data packages, and communicates with Tetra Tech project staff.
Robbin Robl	Laboratory PM/ Manages project	Microseeps	Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides QA of data packages, and communicates with Tetra Tech project staff.
Anita Biernacki	Laboratory PM/ Manages project	Microbial Insights	Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides QA of data packages, and communicates with Tetra Tech project staff.

In some cases, one person may be designated responsibilities for more than one position. For example, the Tetra Tech FOL will be responsible for SSO duties. This action will be performed only as credentials, experience, and availability permits.

SAP Worksheet No. 8 -- Special Personnel Training Requirements Table

(UFP-QAPP Manual Section 2.4.4)

Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response (HAZWOPER) training specified in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 (e). Project-specific safety requirements are addressed in greater detail in the site-specific HASP.

SAP Worksheet No. 9 -- Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1)

Project Name: Groundwater Investigation Plan for OU 19 (Site 44) Feasibility Study Addendum
Site Location: NAS Pensacola, Florida
Projected Sampling Date: TBD
Purpose of Meeting: Data Quality Objectives
Date of Meeting: April 28, 2011

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Patty Marajh-Whittemore	Navy RPM	NAVFAC SE	(904) 542-6202	patty.whittemore@navy.mil	Navy RPM
Julie Corkran	RPM	USEPA	(404) 562-8547	corkran.julie@epa.gov	USEPA RPM
David Grabka	FDEP RPM	FDEP	(850) 245-8997	david.grabka@dep.state.fl.us	FDEP RPM
Greg Campbell	RPM	NAS Pensacola	(850) 452-3131 ext. 3007	Gregory.campbell@navy.mil	Base RPM
Gerry Walker	PM	Tetra Tech	(850) 385-9899	Gerry.walker@tetratech.com	PM
Kay Wischkaemper	Hydrogeologist	USEPA	(404) 562-8641	wischkaemper.kay@epa.gov	Technical support
Frank Lesesne	Technical Expert	Tetra Tech	(850) 385-9899	Frank.Lesesne@tetratech.com	Technical support
Mike Maughon	Technical Expert	Tetra Tech	(843) 886-4547	Mike.Maughon@tetratech.com	Technical support
Brian Caldwell	Hydrogeologist	Tetra Tech	(865) 220-4703	Brian.Caldwell@tetratech.com	Technical support
Mike Singletary	Technical Expert	NAVFAC SE	(904) 542-6303	michael.a.singletary@navy.mil	Technical support
Peggy Churchill	Tetra Tech QA Officer	Tetra Tech	(321) 636-6470	Peggy.Churchill@tetratech.com	DQO Specialist
Ken Bowers	Navy Chemist	NAVFAC	(757)322-8341	kenneth.a.bowers@navy.mil	DQO
Amber Igoe	Staff Scientist	Tetra Tech	(850) 385-9899	Amber.Igoe@tetratech.com	Scribe

Comments/Decisions:
Excerpted from meeting minutes:

Mike Maughon gave the first half of the DQO presentation Monitored Natural Attenuation (MNA) Assessment OU 19, Site 44 Former UST Site 3221 SW and Peggy Churchill presented the second half of the presentation.

Questions/Discussion (first half of presentation)

Q: How was the wash water managed historically?
A: The concrete ditch was present in 1994, the drawings from 1996 will be examined to see if the ditch was present during that time.

Q: Are the water pipes made of clay?
A: The waste water lines are clay and the water pipes are concrete with dovetail joints.

Q: Is the 18" pad the original pad?
A: Yes

Q: Were soil samples from borings next to Building 3221 analyzed for chlorinated volatile organic compounds (cVOCs)?
A: The screening was conducted by a mobile laboratory.

Q: Why were the deep wells installed above the clayey sand?
A: It was determined to screen the wells above the clay. Borings to the clay layer subsequently finished with intermediate wells are proposed as additional field work.

Q: Why was enhanced bioremediation not considered?
A: Based on historic analytical data the concentrations are very low and bioremediation may not be effective.

2nd Half of Presentation DQO Portion (Peggy Churchill)
The discussion was broken into the following topics:

Source Area Identification:

USEPA does not think that a primary source(s) and/or secondary source has been identified at Site 44 and that is required if MNA is going to be selected as remedy. USEPA thinks that the hangar, the flammable storage area and the two undefined storage areas could be potential source(s). FDEP's determined that based on the soil and groundwater data collected from what was expected to be the source area an adequate investigation has been conducted; a source, however, was not able to be identified. One hypothesis is that the chlorinated solvent may have migrated to the peat layer and is acting as a continuous source. This will be addressed by the installation and sampling of intermediate wells.

Horizontal and Vertical Extent of Contamination:

The horizontal extent of contamination will be confirmed after the first round of sampling has been completed. The vertical extent of contamination will be addressed with the installation of four intermediate monitoring wells. It was proposed that one monitoring well will be installed up gradient of the suspected source area; two monitoring wells will be installed along the spine of the plume and one monitoring well down gradient. The intermediate wells will be installed after the analytical results from the first round of sampling (existing monitoring wells) has been reviewed and discussed with the NAS Pensacola Partnering Team.

Conceptual Site Model (CSM):

The CSM will be refined with an updated figure to include subsurface infrastructure and information from the Contamination Assessment Report (CAR) and Remedial Investigation (RI) will be presented in a quantitative way to demonstrate that an investigation for the source(s) area has been completed.

Feasibility Study Work Plan:

Per USEPA RPM's request, a primary document is required during informal dispute and since a Uniform Federal Policy Sampling and Analysis Plan (UFP-SAP) is considered a secondary document a Feasibility Study (FS) work plan will be written instead. The UFP-SAP will be included in the FS work plan and the format will be followed; however, the additional CSM information listed above and remedial alternatives (Soils: No Action and land use controls (LUCs); Groundwater No Action, Air Sparging and Natural Attenuation) will also be included. As per standard practice, all Standard Operating Procedures (SOPs) will be referenced in the Appendix and which agency (FDEP or USEPA) has precedence will be specified.

Proposed Field Work Plan:

Round 1:

- Collect a synoptic round of water levels and total depth measurements for all existing monitoring wells.
- Collect groundwater samples from all existing monitoring wells and analyze for: tetrachloroethene (PCE), TCE, cis-1,2-dichloroethene (DCE), vinyl chloride (VC), iron, manganese, and arsenic; Additional MNA parameters dissolved gases, biological oxygen demand (BOD), and chemical oxygen demand (COD).
- The sewer grates will be examined for evidence of water flow.
- A meeting will be held to discuss the results of the first round of sampling.

Round 2A:

- Four borings will be conducted (1 upgradient, 2 along the spine of the plume, and 1 downgradient) and subsequently completed with a monitoring well.
- A hand auger will be used collect soil samples in the unsaturated zone for screening and submittal to a fixed-based laboratory.
- Borings will be completed to the clay layer (approximately 70 feet) and lithologic information will be collected. Groundwater samples will be collected with a hydropunch at 5-foot intervals and screened with AQR Color-Tec®.
- The four intermediate monitoring wells will be screened based on the information described above.
- A round of synoptic water levels and total depth measurements will be collected and the sewer grates will be examined for evidence of water flow.

Round 2B:

- Existing and new monitoring wells to be sampled and the analyte list will be determined based on the data from Round 1.
- If deemed necessary by the Team, additional technologies [Quantitative Polymerase Chain Reaction (qPCR) for *Dehalococcoides* and functional reductase genes, Compound Specific Isotope Analysis (CSIA) and Stable Isotope Probing (SIP)] may be utilized.
- A meeting will be held to discuss the results of the second round of sampling.

Round 3:

- Monitoring wells to be sampled and the analyte list will be determined based on the data from Rounds 1 and 2.
- If deemed necessary by the Team, additional technologies (qPCR, CSIA and SIP) may be utilized.
- A meeting will be held to discuss the results of all the sampling and a scoping meeting will be held to determine document content and submittal.

Subsequent to the DQO meeting, a NAS Pensacola Partnering Team meeting was held on May 24 and 25, 2011. As part of the meeting, the OU 19, Site 44 UFP SAP DQOs and Problem Statement were discussed. Additional information was provided to the Team concerning laboratory analysis of soil samples and groundwater analysis for arsenic. The Navy indicated that soil sampling for laboratory analysis would not be included in the Problem Statement or included in the field program because the upgradient monitoring well location had previous soil sampling data and any additional possible source areas will show up as a result of the groundwater sampling effort. In addition, analysis for arsenic in groundwater would not be included in the Problem Statement or included in the field program because arsenic was not detected in the previous groundwater sampling events. Also, further discussions (Appendix G) with the USEPA, resulted in the decision to analyze samples for Contract Laboratory Program (CLP) Target Analyte List (TAL)/Target Compound List (TCL) analysis.

SAP Worksheet No. 10 -- Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)

10.1 SITE BACKGROUND

Site 44 is located at the southwest end of Building 3221, which is currently used by the National Museum of Naval Aviation staff to refurbish aircraft used for display. Building 3221 is a large hangar adjacent to Forrest Sherman Field, which was opened in 1955 as the master jet landing field for NAS Pensacola (Figure 10-1). In 1983, Building 3221 was shown as part of the Naval Air Rework Facility (NARF), formerly the NAS Pensacola operations and repair department (NEESA, 1983) and was likely used for aircraft maintenance before the current National Museum of Naval Aviation location opened in 1975.

The National Museum of Naval Aviation, which opened in 1975, is located on Radford Boulevard several hundred feet south of Building 3221 and is not located in Building 3221. Building 3221, which has also been referred to as the Aircraft Maintenance and Restoration Facility, is currently used by staff from the National Museum of Naval Aviation to refurbish aircraft used for museum display. The Navy is planning to conduct a Preliminary Assessment / Site Investigation (PA/SI) separate from the investigation of Site 44. The duration for the PA/SI at Building 3221 is estimated to be from May 2012 to August 2014.

The past and current use of the paved area adjacent to the southwest corner of Building 3221 is a wash rack for cleaning aircraft and aircraft parts. According to National Museum of Naval Aviation personnel, only biodegradable surfactant agents are used by the National Museum of Naval Aviation to clean parts.

As stated in the RI, according to National Museum of Naval Aviation personnel only Simple Green (a biodegradable surfactant agent) is used by the National Museum of Naval Aviation to clean parts (Tetra Tech, 2008). However, limited information is available about the historical maintenance operations or chemicals that may have been used in Building 3221 or the adjacent wash rack area (Site 44). Presumably surfactants and to a lesser extent some solvents (e.g., PD-680 and perhaps TCE) were used in the wash rack area to clean aircraft and aircraft parts. PD-680 was stored in the 1000-gallon underground storage tank (UST) installed at the site in 1967 and removed in 1989-1990. PD-680 solvent, commonly called Stoddard Solvent or mineral spirits, contains petroleum fractions which are complex mixtures of mostly aliphatic hydrocarbons, but which may contain some aromatics and olefinics. According to Federal Specifications for PD-680 and related DoD literature, PD-680 was historically used for dry cleaning and for general cleaning to remove oil and grease from aircraft and engine components and from ground support equipment. Cold solvent cleaning generally takes the form of either spray sinks

or batch loaded dip tanks. Limited amounts of chlorinated solvents (e.g., TCE) may also have been used in the wash rack area to clean aircraft and aircraft parts.

Surface drainage in this area currently flows to a small concrete-lined ditch located on the southeast edge of the pavement. Normal rainfall is directed through this ditch to a storm water catch basin, but when aircraft parts washing activities are being conducted a diverter system is used to direct the run off to the sanitary sewer system where it is treated at the NAS Pensacola Wastewater Treatment Plant (WWTP) (Figure 10-2). Although it is unknown as to the actual date the diverter system was installed, a Navy drawing completed in 1995 indicates that the catch basin was connected to the existing gravity sanitary sewer.

The first and second phase construction drawings for Building 3221 have design dates of 1964 (Submittal Date) and 1966 (Record Drawing Date) (see compact disk in Appendix F, Sheet 25 of 26). The drawings indicate that existing gravity sewer lines were present in the area of Building 3221 prior to its construction. When Building 3221 was constructed, the sewage from the building was conveyed to a lift station via gravity flow and then pumped to an existing gravity sewer system.

The drawing (see compact disk in Appendix F, Sheet 25 of 26) prepared for the construction of the additional area to the east side of Building 3221 indicates that a new lift station was constructed approximately 200 feet southeast of the southeast corner of Building 3221. Connections to the lift station include the diverter system which is located approximately 300 feet to the west-northwest of the lift station, a connection to the original Building 3221 that runs approximately 200 feet to the northwest of the southwest side of the building, and a connection to the new addition to Building 3221 that runs approximately 300 feet to the northeast then turns 90 degrees to the northwest and runs 200 feet to the southeast side of the new addition to Building 3221. The drawing indicates that the pipes are 8-inch diameter or smaller and the material used for construction was not provided. The lift station has an invert of approximately 28.75 feet (the land surface is shown to be approximately 31.5 feet) and connects to an existing 8-inch diameter sanitary sewer that has a slope of approximately 0.25 percent. The existing sanitary sewer pipe runs to the southeast for approximately 1,880 feet where it connects to a lift station with an invert at approximately 21.85 feet (the land surface is shown to be approximately 31 feet). Based on potentiometric surface maps prepared for the Site 44 RI (2008), the sewer system is located hydraulically upgradient to the plume at Site 44 and would not be acting as a preferential pathway for contaminant migration.

The area at the southwest corner of Building 3221 was the former location of a 1,000-gallon UST that was installed in 1967 and reportedly used to store PD-680 (a petroleum distillate cleaning solvent, also known

as Stoddard Solvent). The UST was removed in 1989-1990 and replaced with a new 500-gallon UST used to store waste oil (ABB-ES, 1993).

The 500-gallon waste oil UST was installed during the NAS Pensacola tank removal program conducted during 1989-1990 after the 1,000-gallon UST used to store PD-680 (a petroleum distillate cleaning solvent) was removed from the same location. The 500-gallon waste oil UST was removed on May 2, 1994 (Navy, 1994). There are no USTs remaining at the site. The waste oil stored in this UST was likely generated from aircraft maintenance operations historically performed at Building 3221. In general based on historical reports from installation personnel, some of the waste oil stored in waste oil tanks at NAS Pensacola was contaminated with hydraulic fluids, acids, and paint strippers. Historical methods of disposal of waste oil at NAS Pensacola included removal by contractor, disposal through the WWTP, and disposal to the crash crew fire training activity. The disposal method and collection by a contractor for reprocessing and recycling was in place in 1983 during the Initial Assessment Study (NEESA, 1983) prior to the installation of the waste oil tank at Site 44 in 1989-1990. There is no available information on where the waste may have been stored and handled prior to being transported for the crash crew fire training activity.

The surface cover for the site is primarily 18-inch thick concrete pavement with adjacent areas that have grass, asphalt, or tree cover (Figure 10-2). The north-central portion of the site is covered with concrete, the northwest portion is an asphalt-covered storage area for various aircraft parts and is bounded to the west by a wooded area, the northeast portion abutting Building 3221 is an asphalt parking area, and the southern portion is grass-covered with an unpaved access road trending southwest-northeast through it.

Based on the review of aerial photographs from 1961 to 2010 (Appendix G), which was obtained from the Florida Department of Transportation, the “asphalt paved storage area” to the south-southwest of Site 44 appears to have been used as a “laydown” area for equipment through time. The aerial photographs become too pixilated when enlarged to determine what was temporarily stored at the “asphalt paved storage area.”

10.2 SUMMARY OF PREVIOUS INVESTIGATIONS

The following provides a brief summary of the UST removal actions and assessment activities at Site 44. A more detailed summary of the UST removal actions and assessment activities conducted during the Contamination Assessment (ABB-ES, 1993) and the RI (Tetra Tech, 2008) at Site 44 is provided in Appendix A.

10.2.1 UST Removal Actions

Site 44 was first investigated as UST Site 3221 SW in 1992, following the removal of a 1,000-gallon UST located at the southwest corner of Building 3221. The former tank had been installed in 1967 and was reportedly used to store PD-680 (a petroleum distillate cleaning solvent). The UST was removed during the NAS Pensacola tank removal program conducted in 1989-1990 and replaced with a new 500-gallon UST used to store waste oil (ABB-ES, 1993). The new 500-gallon UST likely stored waste oil generated from aircraft maintenance operations historically performed at Building 3221. This second UST was removed on May 2, 1994 (Navy, 1994). There are no USTs remaining at the site.

During the initial tank removal activities (which occurred between 1989 and 1990), two soil samples were collected at a depth of approximately 6 feet from the excavation, composited and submitted for analysis of Total Recoverable Petroleum Hydrocarbons (TRPH). TRPH was detected at a concentration of 57 milligram per kilogram (mg/kg), which was slightly above the state screening level for TRPH of 50 mg/kg in effect at that time.

Based on the TRPH analytical results, the Site required further investigation under Florida petroleum regulations in effect at that time per Chapter 17-770, F.A.C.

10.2.2 Contamination Assessment Report

In 1992, additional investigations were conducted for a CAR that was prepared as part of the UST investigation (ABB-ES, 1993). The additional investigation consisted of 17 soil borings, 4 temporary monitoring wells, 10 permanent monitoring wells, and 3 groundwater sampling events to assess the extent of contamination at the Site.

Soil Assessment

Analysis of 13 subsurface soil samples was conducted for waste oil group metals (arsenic, cadmium, chromium and lead) and one subsurface soil sample was analyzed for TRPH. The 13 subsurface soil samples were collected at 5 to 7 feet below land surface (bls) and at 2-foot intervals to a depth of 6 feet bls at four boring locations. The soil samples were field screened for organic vapors by the headspace method with a flame ionizing detector (FID). Based on the Organic Vapor Analyzer (OVA) FID results of the soil samples collected from the 13 soil borings, volatile organic vapors ranged from 0 to 1 mg/kg indicating that that petroleum related constituents were minimal. A soil sample collected at a depth of 6 feet bls approximately 4 feet north of the former UST locations contained TRPH at 11 mg/kg, which was slightly greater than the Florida criteria of 10 mg/kg in effect at that time. Analytical results were compared to Florida Direct Exposure Soil Cleanup Target Levels (SCTLs) per Chapter 62-777, F.A.C.

Groundwater Assessment

Groundwater samples were collected from piezometers and monitoring wells installed during three separate events in January, April, and August 1992. During each event the groundwater samples were analyzed for volatile organic compounds (VOCs) USEPA Method 624 list, semivolatile organic compounds (SVOCs) USEPA Method 625 list, total metals (arsenic, cadmium, chromium and lead), and TRPH. Analytical results were compared to Florida Maximum Contaminant Levels per Chapter 62-550 F.A.C., Florida Groundwater Cleanup Target Levels (GCTLs) per Chapter 62-777 F.A.C. and USEPA Maximum Contaminant Levels (MCLs). Below is a summary of these results:

Concentrations of toluene, dibromochloromethane, acetone, and methylene chloride were detected in groundwater samples collected on site in the 1992 site investigation activities and described in the CAR. Toluene was detected at 16 micrograms per liter (µg/L) in two groundwater samples and in the trip blank at 3 µg/L. The detected concentrations are less than its USEPA MCL and Florida GCTL of 1,000 µg/L. The detection of toluene was attributed in the Contamination Assessment Report to cross contamination from the labels on the sample bottles. Additionally, toluene was not detected in subsequent sampling events. Dibromochloromethane was detected at 1 µg/L in one groundwater sample and exceeded its Florida GCTL of 0.4 µg/L, but not the USEPA MCL and the Florida GCTL of 80 µg/L for total trihalomethane. Dibromochloromethane has not been detected in subsequent sampling events. Acetone was detected at 13 µg/L in an equipment blank and did not exceed its Florida GCTL of 6,300 µg/L. Acetone was not detected in a groundwater sample. Methylene chloride was detected in four groundwater samples and a duplicate at concentrations ranging from 13 to 79 µg/L and in the equipment (13 µg/L), trip (14 µg/L) and laboratory (8 µg/L) blanks. Methylene chloride exceeded its USEPA MCL and Florida GCTL of 5 µg/L. Acetone and methylene chloride are common laboratory artifacts and have not been detected in subsequent sampling events.

In January 1992, tetrachloroethene (PCE) was detected at concentrations exceeding the Florida GCTL of 3 µg/L in groundwater samples collected from temporary wells PEN-3221SW-PZ2 (15 µg/L) and PEN-3221SW-PZ3 (9 µg/L).

In April 1992, PCE was detected at concentrations exceeding the Florida Cleanup Target Level (CTL) of 3 µg/L in groundwater samples collected from monitoring wells PEN-3221SW-MW3 (8 µg/L) and PEN-3221SW-MW5 (6 µg/L). August 1992, PCE and trichloroethene (TCE) were both detected at or exceeding their respective Florida CTL of 3 µg/L in effect at that time. PCE was detected in the groundwater sample collected from monitoring well PEN-3221SW-MW8 at a concentration of 3 µg/L.

TCE was detected in groundwater samples collected from monitoring wells PEN-3221SW-MW7 (4 µg/L), PEN-3221SW-MW9 (5 µg/L), and PEN-322lSW-MW10 (25 µg/L).

Based on the findings presented in the CAR, the source of chlorinated solvents in groundwater was not determined during the UST investigation, but was speculated to be associated with the former Building 3629, the flammable storage area located west of Building 3221. Soil samples were not analyzed for chlorinated solvents (i.e., cVOCs) during the investigation; therefore, a definitive statement was not made in the 1993 CAR regarding impacts by chlorinated solvents to that media. The tentatively identified compounds (TICs) identified during the April and August 1992 sampling events are potential breakdown products of fuel; therefore, the former UST was considered to be a possible source of these contaminants.

Upon review of the CAR, FDEP requested that a supplemental assessment be completed around the UST. The supplemental assessment activities were conducted in May 1994 and included removal of the 500-gallon UST, OVA headspace monitoring of soils during UST removal, installation of a single temporary monitoring well (TW-1), groundwater sampling of the temporary well and groundwater flow determination. The groundwater sample was analyzed for VOCs by USEPA Method 624, SVOCs by USEPA Method 625, total metals (arsenic, cadmium, chromium and lead), and TRPH. The assessment results indicated:

- The UST was removed and petroleum contaminated soils were not identified.
- Groundwater flow was from the southwest toward the northeast.
- No petroleum related constituents, TICs or TRPH were detected.
- Cadmium, chromium, and lead were detected in the groundwater sample from temporary monitoring well TW-1.
- Only lead was detected at a concentration (18 µg/L) exceeding the Florida GCTL of 15 µg/L. The lead exceedance was detected in a turbid, unfiltered groundwater sample. The extent of TCE, PCE, and TICs in groundwater was not assessed in the area of the former UST.

Because of the detection of chlorinated solvents in groundwater, the Navy transferred this site to the Installation Restoration (IR) Program for further assessment. Site soil and groundwater did not exceed state petroleum program guideline concentrations for petroleum related constituents; therefore, the site received No Further Action (NFA) for these constituents.

10.2.3 Remedial Investigation Report

Because a release of contaminants at Site 44 appears to have resulted from routine aircraft maintenance operations an RI was performed from 2005 through 2006. The time of disposal or accidental release(s) is unknown. The RI was conducted to delineate the nature and extent of soil and groundwater contamination at potential source areas at Site 44 and to characterize risks to human health and the environment (Tetra Tech, 2008).

Soil Assessment

Field activities for the RI consisted of collecting soil field screening samples from 29 locations for on-site laboratory analysis by a mobile laboratory. The cVOCs included 1,1- and 1,2-dichloroethane (DCA), 1,1- and 1,2-(cis- and trans) DCE, methylene chloride, 1,1,1- and 1,1,2-trichloroethane (TCA), TCE, and PCE. The petroleum related compounds included benzene, toluene, ethylbenzene, xylenes (BTEX), and naphthalene. Soil screening for VOCs with the mobile laboratory identified only one soil boring location with a detectable concentration of PCE that was less than its Florida SCTL.

The results of these field screening soil samples were used to provide a preliminary evaluation of site conditions at potential source areas and to select three locations to collect soil samples that would be analyzed by an off-site laboratory for the full list of analytes in the Contract Laboratory Program-Statement of Work (CLP-SOW) TCL/TAL and TRPH. Only SVOCs and arsenic were found to exceed their respective Florida SCTLs. Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were the only SVOCs detected at concentrations greater than their respective Florida direct exposure SCTLs. The cPAHs were detected in each of the three surface soil samples collected at Site 44, but exceeded Florida SCTLs only at boring location 44SB02 on the east side of the foundation of former Building 3629. Arsenic exceeded its Florida SCTL at one sample location (44SB25), the former location of former UST 3221SW.

Subsequent delineation of cPAHs identified an area around the foundation of former Building 3629. Four soil boring locations (44SB02, 44SB31, 44SB34, and 44SB47) had benzo(a)pyrene equivalent concentrations exceeding the Florida residential direct exposure SCTL. The arsenic delineation sampling indicated that arsenic exceedances were limited to soil boring location 44SB25. Figure 10-3 provides a summary of the laboratory analytical results for soil samples collected during the Site 44 CAR (1993) and RI (2008).

Groundwater Assessment

The results of the soil field screening and off-site laboratory soil samples were also used to select locations for additional monitoring wells that were installed and separately sampled in three phased events to delineate the extent of the cVOC plume. Groundwater samples from existing wells and

monitoring wells installed in the first event (December 2005) were analyzed by an off-site laboratory for the full TCL/TAL list and TRPH. Groundwater samples collected from new monitoring wells installed in the second event (May 2005) were analyzed only for VOCs and four existing monitoring wells were sampled and analyzed for manganese, bis(2-ethylhexly)phthalate, and iron which exceeded GCTLs in the first event. Groundwater samples collected from new monitoring wells installed in the third event (August 2005) were analyzed only for VOCs.

Water level measurements indicated that shallow groundwater at Site 44 flows from southwest to northeast.

Concentrations of chloroform, chloromethane, and 1,1-DCA were detected in Site 44 groundwater samples that were collected in 2005 and 2006 for the RI (2008); but were at concentrations below their federal and state regulatory criteria. However, TCE was detected at concentrations exceeding its GCTL of 3 µg/L in groundwater samples collected from six shallow monitoring wells. The highest detected concentration was in the vicinity of monitoring well PEN-3221-09 (52 µg/L), which was installed as part of the UST investigation and previously had TCE exceedances. TCE was also detected in groundwater samples from monitoring wells PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, PEN-44-22, and PEN-44-24. The TCE concentrations in these monitoring wells ranged from 5 to 34 µg/L. Based on these results, a TCE plume appears to extend north to northeast from the washrack area between Buildings 3629 and 3221. TCE was not detected during the RI in groundwater samples from three shallow monitoring wells (PEN-3221-06, PEN-3221-08, and PEN3221-10) located adjacent to the western side of Building 3221 or PEN-3221-17 located adjacent to the north side of Building 3221. This suggests that Building 3221 is not a source of the TCE plume at Site 44.

Groundwater chemicals of concern (COCs) were established for Site 44 based on the human health risk assessment that employs both USEPA guidelines and the state of Florida methodology for risk characterization. The RI, FS and Proposed Plan identified TCE, bis(2-ethylhexyl)phthalate, iron, and manganese as the COCs in groundwater at Site 44. Concentrations of TCE exceed the USEPA MCL and Florida GCTL and were retained as a COC. Bis(2-ethylhexyl)phthalate (BEHP) was detected in two groundwater samples at concentrations greater than its GCTL of 6 µg/L. However, these two monitoring wells were resampled on May 9, 2006; the BEHP results were less than the laboratory detection limit (5.2 µg/L) and the GCTL; therefore, BEHP was not retained as a COC. The human health risk assessment (HHRA) in the RI also identified iron and manganese as potential COCs because their maximum concentrations exceeded USEPA Secondary MCLs. However, the aquifer is not used as a water supply source in the Pensacola area because of high mineralization. In addition, the Hazard Quotients for iron and manganese calculated by the human health risk assessment in the Site 44 RI

(Tetra Tech, 2008) were less than the USEPA and FDEP goal of 1.0 for non-carcinogenic health effects. The maximum detected concentrations of the two metals were also less than the NAS Pensacola background concentrations. Therefore, iron and manganese were not retained as COCs.

Based on the three sampling events, only TCE was detected at concentrations exceeding the Florida CTL of 3 µg/L in groundwater samples collected from six shallow monitoring wells (Figure 10-4). The TCE plume was identified in the vicinity of PEN-3221-09, which was installed as part of the UST investigation and previously had TCE exceedances in August 1992. The other monitoring wells in the plume extend north from the northwest corner of Building 3221, and include monitoring wells PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, and PEN-44-24. Monitoring wells upgradient of PEN-3221-09 that previously showed exceedances of PCE or TCE during the Contamiation Assessment (ABB-ES, 1993) sampling events (January – August 1992) showed no detections of PCE or TCE during the RI sampling.

Figure 10-5 provides a summary of the laboratory analytical results for groundwater samples collected during the Site 44 CAR (1993) and RI (2008).

Human Health Risk Assessment

The results of the USEPA HHRA for receptors exposed to soil and/or groundwater at Site 44 indicated the following:

- Risks for exposure to Contaminants of Potential Concern (COPCs) in surface and subsurface soil are within the USEPA's target risk range of $1x10^{-4}$ to $1x10^{-6}$ for all receptors.
- Risks exceed $1x10^{-4}$ for exposure to TCE in groundwater by the hypothetical future resident, which exceeds USEPA's target risk range of $1x10^{-4}$ to $1x10^{-6}$.

The HHRA also took into account various Florida SCTLs and GCTLs per Chapter 62-777, F.A.C.

- For soil it was determined that:
    - Risks associated with exposure to cPAHs in surface soil exceeded Florida's SCTLs for hypothetical future residents and lifelong recreational users.
    - Risks associated with exposure to cPAHs in subsurface soil exceeded Florida's SCTLs for hypothetical future residents.
- For groundwater it was determined that:
    - TCE contamination in the groundwater exceeded the Florida CTL of 3 µg/L and is more stringent than the USEPA MCL of 5 µg/L.

Ecological Risk Assessment

An Ecological Risk Assessment was performed during the RI (2008) to evaluate whether ecological receptors are potentially at risk when exposed to chemicals at Site 44. The ecological risk assessment found that the overall level of ecological risk associated with detected contaminants is negligible and that no action is required at Site 44 to protect ecological receptors.

RI Summary

Potential source areas investigated during the RI include the perimeter of the foundation of former Building 3629, which had been used for flammable liquid storage; the former staging area located to the northeast of Building 3629, in a grid pattern at the wash rack to provide full coverage of the area; at the approximate location of the previously removed UST 3221 SW; and the southwest side of Building 3221 which included a former materials staging area that was marked on the concrete. The RI concluded after the investigation of these areas that a release of contaminants (Figures 10-3, 10-4 and 10-5) at Site 44 may have resulted from routine aircraft maintenance activities and storage of materials used in these activities.

Based on the data obtained for the RI, the source and nature of materials, as well as the time of disposal, could not be identified.

10.2.4 Feasibility Study

Based on the results of the RI, an FS was completed in 2010 to establish Remedial Action Objectives (RAOs); cleanup goals, to screen remedial technologies; and to assemble, evaluate, and compare remedial alternatives (Tetra Tech, 2010). The RAOs are established to protect human health and the environment and comply with all pertinent federal and state regulations. Site-specific RAOs specify COCs, media of interest, exposure pathways, and cleanup goals or acceptable contaminant concentrations.

Based on the results of the screening of remediation technologies, the remedial alternatives identified for soil were (Alternative S-0) No Action and (Alternative S-1) LUCs. The remedial alternatives identified for groundwater were (Alternative G-0) No Action, (Alternative G-1) Natural Attenuation, LUCs, and Monitoring, and (Alternative G-2) In-Situ air sparging (AS)/soil vapor extraction (AS/SVE) of the TCE Plume, Natural Attenuation, LUCs, and Monitoring.

The site-specific RAOs that were developed in the Site 44 Feasibility Study (Tetra Tech, 2010) specify COCs, media of interest, exposure pathways, and cleanup goals or acceptable contaminant

concentrations to protect the public from potential current and future health risks, as well as to protect the environment. The following site-specific RAOs were developed in the Site 44 Feasibility Study:

- **RAO 1:** Prevent unacceptable human health risk associated with exposure to soil containing cPAHs with concentrations exceeding the industrial direct exposure PRG and SCTL.

- **RAO 2:** Prevent unacceptable human health risk associated with exposure to groundwater containing TCE with concentrations exceeding the USEPA MCL and FDEP GCTL.

10.2.5 Proposed Plan

A Proposed Plan was completed in 2011 to present findings from the RI/FS and to propose a preferred remedial alternative. The preferred remedial alternative for Site 44 was presented as a combination of Alternative S-1 for soil: LUCs to maintain current site conditions for industrial/commercial SCTLs, and GW-2 for groundwater: natural attenuation, monitoring and LUCs. The preferred alternatives (S-1 and GW-2) are expected to allow Site 44 to be used for the reasonably anticipated future land use, which is non-residential. In addition, implementation of LUCs would prevent unacceptable risks to human health during the period that natural attenuation of TCE in groundwater is occurring.

10.3 CONCEPTUAL SITE MODEL

A summary of the CSM based on current site conditions are shown on Figure 10-6. The text below describes the CSM.

10.3.1 Geology and Hydrogeology

NAS Pensacola is bordered on the south by Big Lagoon, on the south and east by Pensacola Bay, and on the north by Bayou Grande (NEESA, 1983). Sandy surface soil in this area allows for a high proportion of rainfall to infiltrate into the ground and consequently there are few streams. The surface topography has little dissection and the natural drainage system is poorly developed. Much of the surface drainage has been constructed or modified to accommodate structures on base. Swampy areas exist at or near the western portion of NAS Pensacola, and man-made drainage ways and storm drain feed into the short intermittent streams emptying in to Pensacola Bay and Bayou Grande. Perennial streams do not enter or exit NAS Pensacola, but marshy areas and three small lakes on the golf course retain water throughout the year.

Surface water features are not present at Site 44 and storm water runoff from the paved areas is directed into the storm water sewer system at the southwest corner of the pavement (Figure 10-2). A diverter that is connected to the NAS Pensacola sanitary sewer system is used during aircraft washing operations.

An intermittent stream is located approximately ¼ mile to the northeast of the site and is the nearest surface water body. This intermittent stream drains to Bayou Grande approximately ¾ mile to the northeast of the site. Pensacola Bay is approximately ½ mile south of Site 44.

The surficial geology of the area consists of Pleistocene marine deposits made up of light brown to tan, fine quartz sand with associated stringers and lenses of gravel and clay. Underlying these deposits, increasing with age, are the Citronelle Formation, the Miocene Coarse Clastics, the Pensacola Clay, the Tampa Formation, the Chickasawhay Limestone, the Bucatunna Clay member of the Byram Formation, the Ocala Group, the Lisbon equivalent, the Tallahatta Formation, and the Hatchetigbee Formation. The Pleistocene deposits and Citronelle formation are often impossible to differentiate, and together range in thickness from approximately 30 feet to 800 feet across the county (NEESA, 1983).

The lithologies observed during drilling of Site 44 monitoring wells are typical of the undifferentiated Pleistocene marine deposits. The ground surface to 1 foot bls at most of the sampling locations showed signs of disturbance either grading, filling, or pavement construction. Below 2 feet bls to a depth of approximately 25 feet bls the predominant typical lithology include a fine sand ranging from white or tan to dark brown in color. Significant clay or gravel horizons were not encountered. A dark brown, well indurated, peat layer is typically encountered at a depth of approximately 14 feet bls. The thickness of this peat horizon is approximately 1 foot. Most of the shallow wells were installed above this interval. A sand mixed with organic matter is typically encountered from 25 to 35 feet bls, beneath which is a fine sand to a depth of 60 feet bls. A clayey sand is encountered from approximately 60 to 75 feet bls. A clay confining layer is typically encountered at 75 feet bls.

10.3.2 Potential or Known Sources of Contamination

Potential sources of the cVOC groundwater contamination that have been assessed at Site 44 include: the perimeter of the foundation of former Building 3629, which had been used for flammable liquid storage; the former staging area located to the northeast of Building 3629, the wash rack area; at the approximate location of UST 3221 SW; and the southwest side of Building 3221 which included a former materials staging area that was marked on the concrete (Figures 10-3, 10-4, and 10-5). With the exception of one soil boring at the wash rack area, cVOCs were not detected in soil samples collected

above the water table. The cVOCs did not exceed screening criteria at the wash rack area sample location.

Building 3221 was evaluated as a potential historical source of groundwater contamination at Site 44 because of its past use for aircraft maintenance and because of the former materials staging area previously located in the wash rack area adjacent to Building 3221.

No additional information is available about the specific aircraft maintenance activities conducted inside Building 3221 nor the potential chemicals and waste handling practices associated with these activities. However, according to installation personnel, no spills or releases have been reported at Building 3221. The Initial Assessment Study performed in 1983 identified Building 3221 as part of the NARF facilities. This is shown by Figure 5-1 from the Initial Assessment Study (NEESA, 1983), which is provided in Appendix G. This figure indicates most of the NARF facilities were located on the eastern side of NAS Pensacola near Chevalier Field where more intensive industrial operations occurred. No findings for Building 3221 were identified in the study and the building was not one of the facilities recommended for confirmation study. The only items associated with Building 3221 in the study are two waste oil tanks located in the vicinity of Building 3221 that have since been removed as part of the tank removal program in 1989-1990.

Also, based on the results of site investigations during the Contamination Assessment (ABB-ES, 1993) and RI (Tetra Tech, 2008) at Site 44, including soil and groundwater sampling along the southwest side and northwest corner of Building 3221 as further detailed below and in Appendix A, the source of the Site 44 TCE groundwater plume appears to be due to wash rack activities and is not the result of activities inside Building 3221.

Building 3629 is an open-sided shed that was assigned by NAS Pensacola to be part of the facilities for Hangar 3221 that were to be operated by the National Naval Aviation Museum (NNAM) after the Naval Aviation Depot vacated the building. The open-sided shed was originally located adjacent to and northwest of the 3221 wash rack (about 60 yards west of Hangar 3221 west wall). The concrete slab that held the structure is still in place. In about 2000, it was moved to its present location immediately adjacent to the west wall of Hangar 3221. Before being moved, this building was used for storage of a few pieces of rolling stock and also held storage lockers for hazardous materials, primarily acetic acid and a corrosion inhibitor (commercial name: "Corrosion Block"). This storage had the approval of NAS Pensacola Safety authorities. Its present use is for the storage of equipment primarily used at the wash rack and some other small rolling stock. Chemicals have not been stored in the structure since it was moved.

A small un-numbered building formerly located east of Building 3629 is not apparent in an aerial photograph taken on October 11, 1993 (Appendix G; Photograph 8 in Attachment 5), but appears in two aerial photographs one taken on February 15, 1997 and the other taken on February 15, 2000 (Appendix G; Photographs 9 and 10 in Attachment 5). The building does not appear in an aerial photograph taken on March 12, 2004 (Appendix G; Photograph 11 in Attachment 5). Based on the a review of the 1993 CAR, the small building was not present at the time the assessment activities were conducted and the CAR indicated that Building 3629 was a flammable storage area and a possible source for the chlorinated solvents.

The un-numbered structure, that was adjacent to Building 3629, was a portable metal shed mounted on a trailer. It was originally built to store products (believed to be items such as souvenirs and programs) in support of the Naval Aviation Museum Foundation (the private support organization for the air show sales program). During this time, it was located on the 3221 aircraft parking line or adjacent to Building 3695 (NNAM Exhibits Fabrication Building), which is off site from Hangar 3221. Following the Foundation's termination of the air show sales program, the structure has been used by NNAM for storage of line gear (e.g., tie-downs, chocks, etc.) and other dry storage. No chemicals have been stored in this structure.

Soil and groundwater sampling performed during the Contamination Assessment (ABB-ES, 1993) and RI (Tetra Tech, 2008) along the southwest side and northwest corner of the building adjacent to Site 44 indicate Building 3221 is not a source of contamination for the Site 44 groundwater contamination. As indicated in Appendix A2, during the RI, direct push technology (DPT) soil sampling was conducted at 2-foot intervals to a depth of 6 feet (approximate top of water table) on a grid pattern in the wash rack area adjacent to Building 3221. Seven of these soil sample locations were spaced along the southwest side and northwest corner of Building 3221 (Appendix A2, Figures 2-1 and 4-1). The soil samples collected from the DPT borings were analyzed on site for a select list of cVOCs and petroleum related compounds by a mobile laboratory. The cVOCs included 1,1- and 1,2-DCA; 1,1- and 1,2-(cis and trans) DCE; methylene chloride; 1,1,1- and 1,1,2-TCA; TCE; and PCE. The petroleum related compounds included BTEX and naphthalene. Based on the mobile laboratory analytical results, only one DPT soil boring (44SB11) contained a detectable concentration of a target analyte. PCE was detected at 0.028 mg/kg and did not exceed SCTLs (Appendix A2 Figure 4-1). The target analytes were not detected in the soil samples collected from any of the other DPT soil boring locations, including the seven sample locations along the southwest side and northwest corner of Building 3221. In addition, shallow monitoring wells located along the southwest side (PEN-3221-06, PEN-3221-08, and PEN-3221-10) and northwest side (PEN-44-17) of Building 3221 showed no detections of cVOCs during the RI, and the deep well located

along the southwest side (PEN-44-19) of Building 3221 only detected cis-1,2 DCE at 1 µg/L, well below the respective Florida GCTL of 70 µg/L.

The paved area located adjacent to the southwestern corner of Building 3221 has in the past and is currently used as a wash rack for cleaning aircraft and aircraft parts. Surface drainage in this area currently flows to a small concrete-lined ditch located on the southeastern edge of the pavement. When aircraft or aircraft parts-washing activities are being conducted, a diverter system is used to direct the runoff to the sanitary sewer system for treatment at the NAS Pensacola WWTP (Figure 10-2). Although it is unknown as to the actual date the diverter system was installed, a Navy drawing completed in 1995 indicates the catch basin connected to the sanitary sewer.

Based on data from the CAR (1993) and RI (2008), the primary source of cVOC groundwater contamination at Site 44 is believed to be from routine aircraft or aircraft parts- maintenance and washing activities or undocumented minor spills in the wash rack area (Figures 10-3, 10-4, and 10-5). The current hypothesis is that dilute wash down water from historical wash rack operations may have seeped through concrete pavement construction joints and/or runoff the concrete wash rack area to adjacent grassed areas and seeped into groundwater (Figure 10-6).

10.3.3 Migration Pathways and Potential Receptors

Site 44 has been an industrial area supporting aircraft maintenance and refurbishing for more than 30 years. The contaminants at Site 44 appear to be limited to surface soil and, subsurface soil (Figure 10-3), and groundwater (Figures 10-4 and 10-5). Migration pathways may include a low level dissolved phase TCE and natural attenuation degradation products in a hydraulic downgradient direction (Figure 10-6).

As indicated in the CSM, low level dissolved phase TCE is suspected to have seeped through concrete pavement cracks in the wash rack area or runoff to adjacent grassed areas resulting in shallow groundwater contamination. The TCE plume map (Figure 10-4), cis-1,2-DCE Results Map (Figure 10-7), and limited geochemical data, including oxidation reduction potential (ORP) measurements (Figure 10-8), indicate geochemical oxidation-reduction conditions become more favorable for reductive dechlorination and complete natural attenuation of TCE and its daughter products occurs in the more downgradient area of the plume where the aerobic effects of rainfall infiltration are limited by the extensive area of concrete pavement (Figure 10-9). In addition, the peat layer encountered at a depth of approximately 16 feet at most monitoring well locations is expected to provide a natural source of organics to stimulate reductive dechlorination.

In addition, reductive dechlorination of PCE and TCE is expected to have occurred in the upgradient area of the plume located between monitoring well PEN-3221-09 and the previously removed UST 3221SW as a result of a petroleum carbon source released from the UST (TIC petroleum breakdown products detected during the Contamination Assessment [ABB-ES, 1993] investigation). PCE and TCE detected in this area during the Contamination Assessment (ABB-ES, 1993) were not detected during the RI (Tetra Tech, 2008) in any monitoring wells in this area except PEN-3221-09. The ORP measurements made during the RI (Figure 10-8) indicate strongly reducing conditions favorable for reductive dechlorination in the area just downgradient of the former UST.

The groundwater data at Site 44 do not provide evidence of immiscible contaminants at concentrations exceeding water solubility levels. Therefore, the migration of contaminants in groundwater, for the most part, is likely governed by factors such as advection, dilution, dispersion and sorption (retardation) that govern the movement of dissolved contaminants.

The TCE concentrations in groundwater are relatively low, and volatilization is not likely to occur. Air monitoring was conducted during the soil investigation due to the potential for dust/particulate exposure. Because of the concrete pavement and sandy soil at the site, little dust is generated under normal conditions. However, there is a potential for particulate exposure in areas without pavement or grass or if the soil is significantly disturbed (e.g., during excavation).

Because most of the site and the adjacent hydraulic downgradient area are paved with concrete for approximately 1,000 feet, there is no known completed human health risk pathway. Site reuse is expected to be industrial for the foreseeable future. Current and potential receptors at Site 44 include adult and adolescent trespassers, maintenance workers, construction workers, occupational workers, and hypothetical future residents.

The site is currently covered with concrete that limits the infiltration of storm water into the subsurface during precipitation events. A storm sewer runs from south to north along the west side of Building 3221 to a ditch located at the end of the concrete pavement approximately 800 feet north of Site 44. The invert elevation of the storm sewer in the area of Site 44 is approximately 6 feet bls which is close to the depth of water table. Based on the uniformity of groundwater elevation isocontours, groundwater infiltration to the storm sewer does not appear to be occurring.

SAP Worksheet No. 11 -- Project Quality Objectives/Systematic Planning Process Statements

(UFP-QAPP Manual Section 2.6.1)

This section describes the development of Project Quality Objectives (PQOs) using the USEPA seven-step DQO/Systematic Planning Process.

11.1 PROBLEM STATEMENT

In February 2010, the Navy presented a Draft Proposed Plan for OU 19, Site 44, in which MNA was presented as the preferred remedial alternative for the Site. The Project Team has identified several data gaps that must be resolved to evaluate the efficacy of MNA and other appropriate groundwater remedial alternatives in the FS Addendum. Groundwater remedial alternatives currently being considered for further evaluation include: 1) no action, 2) MNA, 3) air sparging followed by MNA, and 4) enhanced bioremediation followed by MNA. Following this evaluation, the Project Team will select the most appropriate remedial alternative. The data gaps include:

- Confirm current groundwater information at Site 44 by TCL/TAL analysis of selected monitoring well locations since these analyte lists have been updated since full scan sampling was performed at the site.
- Confirm current groundwater information at Site 44 by analysis of PCE and its daughter products at selected monitoring well locations.
- Evaluate aquifer chemical and hydrogeologic characteristics to determine the capacity of the aquifer through natural processes, or remedial technology enhancement to adequately reduce contaminant concentrations to federal and state MCLs per the Federal Safe Drinking Water Act (SDWA) and Florida regulation (Chapter 62-550, F.A.C.) and/or GCTLs (Chapter 62-777, F.A.C.) within an appropriate timeframe. Additionally, the data will be compared to the most recent USEPA Regional Screening Levels (RSLs) published in http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm.
- Determination of the vertical and horizontal extent of contamination and whether the plume is potentially shrinking, stable or expanding.
- Determination of groundwater chemical concentration trends.

- Supplement the existing TCL/TAL soil sample results in the RI, and provide information to:
  - Confirm that the grassed area is not a source for the analytes detected in groundwater.
  - Confirm direct soil exposure human health by comparison of the analytical results to Project Action Limits (PAL)s.
  - Assess the potential for a contaminant(s) to leach to groundwater.

11.2 DATA NEEDS

Data that are required to resolve the problem described in the Problem Statement are as follows:

- Previously collected data: Data collected during the Contamination Assessment and the RI will be used for trend analysis and other site characterization exercises.

- Soil Field screening techniques: OVA and AQR Color-Tec® field screening techniques and lithology will be used to select soil samples for analysis at a fixed based laboratory.

- Chemical soil data: Soil samples collected at the three locations in the grassed area adjacent to Building 3629 will be analyzed at a fixed-based laboratory for concentrations of USEPA CLP TCL and TAL metals and hexavalent chromium. The complete list of analytes is presented in Worksheet No. 15.

- Sample all currently existing shallow and deep wells (PEN-44-18 and PEN-44-19) during the initial sampling event.

- Install intermediate and deep wells prior to the second round of data collection. The Project Team will optimize the sampling strategy. The Project Team is planning on performing three quarterly sampling events.

- Groundwater Field screening techniques: OVA and AQR Color-Tec® field screening techniques and lithology will be used to determine well depths and screen intervals for newly installed monitoring wells.

- Chemical groundwater data: Groundwater concentrations of CLP TCL analytes, including PCE, TCE, cis-1,2-DCE, VC, TAL metals, and hexavalent chromium will be analyzed at a fixed-based laboratory. The complete list of analytes is presented in Worksheet No. 15. The analytes selected for each monitoring well location during the initial sampling event are listed in Worksheet No. 18.

- Based on the results of previous sampling events, the Partnering Team will select the analytes for each monitoring well location for the subsequent event(s) and revise Worksheet No. 18 accordingly.

- Synoptic groundwater level measurements will be completed during each round of sampling at all site monitoring wells as presented in Worksheets No.14 and 17.

- The sewer grates will be examined during each round of sampling for evidence of water flow as presented in Worksheets No. 14 and 17.

- Natural Attenuation parameters: iron and manganese (total and dissolved); gases (methane, ethane, ethene, nitrogen, hydrogen and carbon dioxide); anions (chloride, nitrate, nitrite and sulfate); alkalinity; COD; and BOD will be measured at a fixed-based laboratory.

- Groundwater field parameters: dissolved oxygen, temperature, ORP, pH, and turbidity will be used to evaluate the aquifer and to determine when groundwater is representative of site conditions. The SOPs are provided in Appendix B.

- Global Positioning System (GPS) coordinates (sub-meter accuracy) of previous and new data collection points. The previous data locations are required to serve as points of reference for new data collection points. Data collection point coordinates must be documented in the State Plane Coordinate System (SPCS) North American Datum (NAD) 1983, Florida North (feet).

- Additional information inputs may be required to make decisions regarding the efficacy of MNA at the site including qPCR for Dehalococcoides and functional reductase genes, CSIA, and SIP. The decision making process for the potential collection of this data is presented in Worksheet No. 17.

In addition, the above data, as determined during the DQO meeting, were revised based on additional comments by the USEPA and FDEP (please refer to Appendix G, Attachment 1, pages 5 through 8 of 8), Worksheet No. 11 and Worksheets No. 17 and 18 (formerly Worksheet No. 7) will be revised to include groundwater samples to be collected for analysis of TCL/TAL analytes from a specific subset of monitoring wells as listed in the USEPA's email dated January 30, 2012. The basis for USEPA's request for TCL/TAL analysis at select wells is because the USEPA CPL TAL/TCL list of analytes has been updated since full scan sampling was performed at the site during the RI in 2005, and there are constituents that may not have been sampled at the site. Likewise, TCL/TAL analyses will be conducted

for groundwater samples collected from the new intermediate and deep monitoring wells that are proposed to be installed under the current UFP-SAP, because they will be screened in zones of the aquifer not previously sampled.

Also, natural attenuation parameters will be collected only at select wells during the first sampling event to establish the footprint of redox conditions along the centerline and edges of the plume to assess the favorability of redox conditions along and downgradient of the plume for complete sequential reductive dechlorination, or other biological or abiotic degradation. This includes all existing centerline plume wells where redox conditions may be expected to change with distance along the plume and well locations representative of conditions upgradient, side gradient, and downgradient of the plume. These well locations should provide sufficient information to determine the redox conditions in those areas that may be unaffected by plume COCs. In addition, each subsequent sampling event will be optimized based on the results each preceding sampling event. The optimization of subsequent sampling events will consist of the Project Team determining the location of each well to be sampled as well as the analytical parameters including COCs and natural attenuation parameters.

The USEPA also requested that selected soil and groundwater samples be analyzed for hexavalent chromium based on revision to USEPA RSLs (please refer to Appendix G). In addition, the maximum detected concentration of chromium (15.3 mg/kg) at Site 44 exceeds two times the NAS Pensacola background concentration for chromium (6.1 mg/kg); therefore, speciation of chromium is recommended per USEPA's memorandum dated September 30, 2011.

11.3 STUDY BOUNDARIES

Groundwater

The vertical boundary is currently defined by the top of the groundwater table to the top of the blue marine clay layer. The horizontal boundary is currently defined by the extent of the monitoring well network. The horizontal boundary may change based on the groundwater analytical results from the first round of data collection.

Groundwater populations of interest include groundwater within the shallow, intermediate, and deep portions of the aquifer. The intermediate and deep zone of the aquifer will be investigated with the installation of new monitoring wells during the second data collection event as this interval of interest is currently not adequately characterized. Additionally, saturated soil will be investigated to a depth of

75 feet bls using continuous Rotosonic drilling techniques to obtain lithologic data to characterize the subsurface.

Soil

The horizontal boundary is currently based on existing sampling points. The vertical boundary is the unsaturated zone (land surface to the water table).

11.4 ANALYTIC APPROACH

Data collected from the CAR, the RI, and three rounds of additional monitoring will be used to evaluate remedial alternatives for groundwater in an FS Addendum and for soil to supplement the existing TCL/TAL data provided in the RI. For this evaluation to occur, additional groundwater data will be collected over three rounds of sampling at Site 44 and soil samples will be collected during one event at three locations.

The dynamic sampling design and related installation of four new monitoring well clusters, (locations to be based on the analytical results of the first sampling event), are described in Worksheet No. 17 for the three quarterly sampling events covered by this SAP.

The decision rule that is applicable to the first of a minimum of three rounds of data collection as agreed to by USEPA, FDEP, and the Navy during the DQO meeting is as follows.

If the Project Team's evaluation of the data from the first quarterly sampling event indicates the plume has migrated beyond the limits of the existing monitoring wells, the Partnering Team will determine the location of additional wells to be installed to better evaluate plume migration and/or stability, and proceed accordingly with the provisions described under Groundwater Sampling in Worksheet No. 17. Otherwise, the Project Team will proceed in accordance with well installation and other provisions described under Groundwater Sampling in Worksheet No. 17.

After each of the first and second rounds of data collection, the Project Team must convene (Partnering Team Meeting or Teleconference) to review the newly collected data, develop DQOs, and design a sampling program for the next sampling event to meet project objectives. A Technical Memorandum will be prepared to document the findings of the newly collected data, document the DQOs that were developed, and describe the design of the future sampling event.

Additionally, per the request (January 17, 2012) of the USEPA, three soil borings will be collected in the grass covered area adjacent to former Building 3629 located to the west of Building 3221. This area was characterized for the presence of SVOCs during the Site 44 RI (2008). The decision rule that is applicable to the three soil sampling locations is as follows.

If a maximum measured chemical concentration does not exceed its Project Action Limit (PAL) and background sample concentration in soil for a particular boring location, then the chemical will be excluded from further consideration, else the Project Team will discuss what additional measure needs to be taken.

11.5 PERFORMANCE CRITERIA

Data collected during this investigation must be representative of the targeted groundwater population, generated by sufficiently sensitive analytical methods that are operating within QC limits, and comparable in terms of quality and representativeness in light of project objectives and decision rules. Laboratory QC limits and PALs are presented in subsequent worksheets.

Soil PALs include: USEPA RSL for residential exposure and protection of groundwater (published in http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm) and Florida SCTLs per Chapter 62-777, F.A.C. for direct residential exposure and leachability to groundwater.

PALs for groundwater include: USEPA MCLs [SDWA (1974; amended in 1986 and 1996)], Florida MCLs per Chapter 62-550, F.A.C., GCTLs per Florida Chapter 62-777, F.A.C., Table I; and USEPA RSLs for Tapwater (published in http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm for tapwater).

To evaluate data quality, the processes and criteria described in Worksheets No. 34 and 35 will be used. If the data collected are considered sufficient they will be used to support the evaluation of remedial alternatives in an FS Addendum. Data quality deficiencies must be brought to the attention of all Project Team members for their consideration as to how the deficiencies affect attainment of project objectives.

11.6 SAMPLING DESIGN AND RATONALE

Details are provided in Worksheet No. 17.

SAP Worksheet No. 12 -- Measurement Performance Criteria Table – Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2)

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPC)
Trip Blank	cVOCs and VOCs	One per cooler	Accuracy /Bias/ Contamination	No target analytes > ½ Limit of Quantitation (LOQ) >LOQ for common laboratory contaminants), unless target analytes in field samples are > 10x those in trip blank.
Equipment Rinsate Blank(1)	cVOCs, VOCs, SVOCs (including low level PAHs), Pesticides, PCBs, and Metals	One per 20 samples	Accuracy /Bias/ Contamination	No target analytes > ½ LOQ (>LOQ for common laboratory contaminants), unless target analytes in field samples are > 10x those in rinsate blank.
Field Duplicates	cVOCs, VOCs, SVOCs (including low level PAHs), Pesticides, and Polychlorinated Biphenyls (PCBs)	One per 10 samples	Precision	Relative percent difference (RPD) must be ≤ 30% for aqueous sample and ≤ 50% for soil samples. If sample results are < 2x LOQ, professional judgment is used.
	Metals (including mercury, dissolved iron and manganese, and hexavalent chromium)	One per 10 samples	Precision	For values ≥ 5x LOQ RPD must be ≤ 30% for aqueous sample and ≤ 50% for soil samples. For values < 5x LOQ Absolute difference must be ≤ 2x LOQ.
Temperature Blank	All analytical groups	One per cooler	Representativeness	Temperature must be ≤ 6 Degrees Celsius (^{o}C).

1. Equipment rinsate blanks will be collected if non-dedicated sampling equipment is used. For disposable equipment, one sample per batch of disposable equipment will be collected.

SAP Worksheet No. 13 -- Secondary Data Criteria and Limitations Table

(UFP-QAPP Manual Section 2.7)

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/ collection dates)	How Data Will Be Used	Limitations on Data Use
Initial Assessment	Initial Assessment Study of NAS Pensacola, Florida (1983)	Naval Energy and Environmental Support Activity (1983)	Previous site information	None
Contamination Assessment	Contamination Assessment Report, Site 3221 NW Naval Aviation Depot, NAS Pensacola, Florida (1993)	ABB-Environmental Services, Inc. (ABB-ES) (1992)	Previous investigation data	None
Storage Tank Closure Report	Letter from Timothy Thomson NASP Commanding Officer to W. E. Grimsley, Supervisor UST Program Escambia County Health Department. Storage Tank Closure, UST at Building 3221 NAS Pensacola , Florida (1994)	Department of Navy (1994)	Previous investigation data	None
UFP SAP	Sampling and Analysis Plan For Site Characterization at Installation Restoration Site 44 (Former UST Site 3221 SW) NAS Pensacola, Florida (2005)	Tetra Tech NUS, Inc. (2005)	Previous site information and Work Plan for Environmental Sampling	None
Remedial Investigation	Remedial Investigation Report For Site 44 (Former UST Site 3221 SW) NAS Pensacola, Florida (2008)	Tetra Tech NUS, Inc. (2005 and 2006)	Previous investigation data	None
Feasibility Study	Feasibility Study for Operable Unit 19 Site 44 - Former UST Site 3221 SW NAS Pensacola, Florida (2010)	Tetra Tech NUS, Inc. (2005 and 2006)	Previous investigation data and Remedial Alternatives Evaluation	None

SAP Worksheet No. 14 -- Summary of Project Tasks

(UFP-QAPP Manual Section 2.8.1)

14.1 FIELD PROJECT TASKS

The field tasks are summarized below. A short description of these tasks is also provided.

- Mobilization/Demobilization
- Monitoring Equipment Calibration
- Soil Sampling
- Monitoring Well Installation and Development
- Water Level Measurement
- Monitoring Well Sampling
- Investigation-Derived Waste (IDW) Management
- Field Decontamination Procedures
- Field Documentation Procedures

Additional project activities include the following tasks:

- Analytical Tasks
- Data Management
- Data Assessment and Oversight
- Data Reviews
- Project Reporting

Field procedures will follow USEPA, Region 4, Science and Ecosystem Support Division (SESD), Athens, Georgia, Field Branches Quality System and Technical Procedures. These procedures contain routine field sampling and measurement procedures, and QC documents used by field investigators of the SESD Field Branches: the Ecological Assessment Branch and the Enforcement and Investigations Branch. If USEPA, Region 4, SESD does not have an applicable field procedure, then FDEP SOPs will be used, and if USEPA or FDEP SOPs are not available, then Tetra Tech SOPs will be used. SOPs are located in Appendix B in the order of USEPA, FDEP and Tetra Tech. A summary of each task is discussed in this worksheet.

14.1.1 MOBILIZATION/DEMOBILIZATION

A field team orientation meeting will be conducted prior to the start of fieldwork to familiarize the team personnel with the site's health and safety requirements, objectives and scope of the field activities, and chain-of-command. This meeting will be attended by the Tetra Tech FOL/SSO, PM, and field crew staff, as necessary. Mobilization activities will include transporting field personnel, equipment, and supplies to the site. All drilling equipment and sampling tools will be cleaned prior to arrival on-site. A 1-hour health and safety meeting will be conducted prior to initiating on-site activities with all field crew staff. Tetra Tech will coordinate with the Navy POC at NAS Pensacola regarding security and access issues, and daily activities. Tetra Tech SOP HS-1.0 provides information on utility locating and clearance. Tetra Tech will also coordinate with the Navy RPM and stakeholders regarding the field activities. Potable water and electricity are available at the Site, however, subcontractors will be required to have a portable source of electricity. Sanitary facilities are not available at the work site. Because of the short duration of the field activities, project field office and storage areas are not provided.

Because of the short duration of the field activities, field equipment will be checked for completeness and operation by the field operation leader prior to mobilization. Spare parts will not be maintained in the field and will be shipped by the equipment supplier by express delivery, if needed.

Demobilization will include transporting personnel, field equipment, and supplies from the site, performing general site cleanup, and organizing and finalizing field paperwork.

14.1.2 MONITORING EQUIPMENT CALIBRATION

Calibration procedures for in-situ water quality monitoring will be conducted as per manufacturer's instructions and USEPA SOPs In Situ Water Quality Monitoring (SESDPROC-111-R2).

14.1.3 SOIL SAMPLING

Three soil borings in the grassed area adjacent to Building 3629 (at locations shown in Worksheet No. 17, Figure 17-1) will be advanced to the water table (approximately 4 feet bls), using a stainless steel hand auger. Soil borings will also be advanced at the location of new monitoring well clusters with a stainless steel hand auger from the land surface to a depth of 4 feet bls to confirm utilities are not present. At each of these soil boring locations, soil samples will be collected at 2-foot intervals, visually described and screened for evidence of the presence of VOCs with a FID and the AQR Color-Tec® methodology.

Screening soils with a FID for the presence of VOCs will be conducted according to the methodology in Chapter 62-770, F.A.C. OVA readings per this methodology are obtained from soil samples using an organic vapor analysis instrument with a FID in the survey mode. The measurements are obtained from the sample container headspace of a half-filled, 8- or 16-ounce jar. Each soil sample is split into two jars, the two sub-samples that are brought to a temperature between 20° C. (68° F.) and 32° C. (90° F.); readings are obtained 5 to 30 minutes, thereafter. One of the FID readings will be obtained with the use of an activated charcoal filter unless the unfiltered reading is non-detect. The total corrected measurement shall be determined by subtracting the filtered reading from the unfiltered reading. A photo ionization detector (PID) may also be used, but shall not be used in situations where humidity will interfere with the instruments sensitivity (including periods of rain, measuring wet or moist soil). If an instrument with a PID is used, a filtered reading is not warranted and therefore sample splitting is not necessary.

The AQR Color-Tec® methodology for field screening for cVOCs will be conducted for soil samples collected from the aforementioned three soil boring locations and from borings completed for the installation of monitoring wells. The AQR Color-Tec® methodology utilizes a hand operated vacuum pump to purge volatile compounds from a sample through colorimetric gas detector tubes. The tubes are designed to produce a distinct color change when exposed to all chlorinated volatile organic halocarbons (cVOHs) including saturated and unsaturated chlorinated alkenes and alkanes. This field screening method will only be used to determine the presence of cVOHs on a qualitative basis and not used to yield quantitative data for comparison against regulatory screening levels. The AQR Color-Tec® method will be conducted in accordance with USEPA's SOPs for Analysis of Total Chlorinated Ethenes in Soil and Groundwater Using the Color Tec Screening Method (http://www.epa.gov/superfund/programs/dfa/fldmeth.htm) and AQR Color-Tec® Method Procedures Manual. Any qualitative signs of potential contamination (such as odor or staining) will also be noted.

Two soil samples will be collected from each boring conducted in the grassed area adjacent to Building 3629 for off-site laboratory analysis. Soil samples for laboratory analysis will not be collected from borings completed for monitoring well installation. One surface sample (land surface to 2 feet bls) will be collected at each location. The subsurface soil sample from each location will be selected by the FOL to represent the highest of the field screening measurements (OVA FID/PID and/or AQR Color-Tec®) or staining or olfactory observations. In the event that OVA and AQR Color-Tec® data do not indicate the presence of volatile organics and there is no obvious staining or olfactory observations, the soil samples will consist of a surface soil sample (0 to 2 foot bls) and subsurface soil sample from the 2-foot interval above the water table encountered at the time of the field activities.

The soil samples for off-site laboratory analysis will be placed in coolers, refrigerated with wet ice, and submitted under chain of custody protocol to a fixed-base laboratory for the parameters listed in Worksheet No. 15.

14.1.4 MONITORING WELL INSTALLATION AND DEVELOPMENT

Monitoring well installation and development will be conducted in accordance with USEPA Field Branches Quality System and Technical Procedures, November 1, 2007, Section 3.1, the USEPA SOP Design and Installation of Monitoring Wells (SESDGUID-101-RO), Tetra Tech SOP GH-2.8 and in compliance with the Northwest Florida Water Management District rules and regulations.

Soil borings at new monitoring well cluster locations will be initiated with a stainless steel hand auger from the land surface to a depth of 4 feet bls to confirm utilities are not present. A rotosonic rig will then be used to install the 10 new monitoring wells. Drilling methods and procedures to install the monitoring wells will follow standard industry practices in accordance with Navy requirements for monitoring well design and installation. A dig permit will be obtained from the Navy and Sunshine One Call will be called to locate all utilities prior to field work. Before the monitoring wells are installed, all locations will be hand augered to 4 feet bls to confirm that the area is cleared of utilities.

Each new shallow monitoring well will be advanced to a depth of approximately 15 feet bls and screened across the water table. The depth of the intermediate and deep monitoring wells will be determined based on data collected from borings completed to the marine clay layer, which is at approximately 70 feet bls. At the locations of the new intermediate and deep monitoring wells, groundwater samples will be collected with a Hydro-Punch® at 5 foot intervals and field screened with AQR Color-Tec®. Any water in the sampler will be purged prior to advancing to the next depth interval and any equipment used to extract the sample (i.e., tubing/pump or bailer) will be decontaminated between samples, unless dedicated equipment is used. In addition, the Hydro-Punch® sampler will be decontaminated between each boring location in accordance with USEPA guidance. The FOL will select screen interval depths for the intermediate and deep wells based on inspection of the soil cores and identification of the more transmissive lithologic zones, which are expected to be within the respective intermediate and deep sand layers shown in the CSM (Figure 10-6), i.e., within the “Sand, Very Fine to Fine Grained” layer located directly below the “Organic Peat Layer”, and within the “Sand” layer that overlies the “Clayey Sand” layer.

Each shallow monitoring well will be constructed of nominal 2-inch diameter, schedule-40 polyvinyl chloride (PVC) with 10 feet of 0.10-inch slotted screen and PVC end-cap or well point at the bottom of each well. Each intermediate and deep monitoring well will be constructed of nominal 2-inch diameter, schedule-40 PVC with 5 feet of 0.10-inch slotted screen and PVC end-cap or well point at the bottom of each well. The outside annular space of each well screen and adjacent formation sands will be filled with 20/30 silica sand to 2 feet above the well screen. In addition, a minimum 1 foot of fine choke sand (30/65 graded) will be placed above the sand pack for the shallow monitoring wells. The intermediate and deep monitoring wells will have a bentonite seal, a minimum 1 foot, placed above the sand pack.

Each monitoring well will be properly grouted above the sand pack or bentonite seal using neat Type II Portland cement and completed in a flush mount 8-inch diameter bolt down at grade well vault capable of supporting traffic loads. Each monitoring well vault will be emplaced in 6-inch thick, 2-feet by 2-feet flush mount pad so that the edges are flush to the ground surface. A water-tight locking well cap will be provided for each monitoring well.

Upon completion and allowing sufficient time for the grout to cure (minimum 24 hours), each shallow, intermediate and deep monitoring well will be developed by over pumping with a peristaltic pump until it produces relatively sediment free water as determined by the Tetra Tech's on-site personnel.

After the wells are installed they will be developed until all fine material and drilling water is removed from the well. Sequential measurements of field parameters including pH, specific conductance, turbidity and temperature will be taken during development to yield information (stabilized values) regarding whether sufficient development has been performed. The selection of the well development method shall be made by the field geologist and is based on the drilling methods, well construction and installation details, and the characteristic of the formation that the well is screened in.

All monitoring wells will be surveyed by a Florida licensed professional surveyor.

14.1.5 WATER LEVEL MEASUREMENTS

A synoptic round of electron water-level measurements will be conducted as part of each groundwater sampling event to provide information regarding groundwater flow patterns and hydraulic gradients. In addition to monitor the potential for groundwater to infiltrate storm sewers, the storm water drains at Site 44 will be visually inspected to determine if water is present and visibly flowing during periods of no rainfall. Water level measurements will be made using procedures described in USEPA SOP

Groundwater Level and Well Depth Measurement (SESDPROC-105-R1). Water level measurements will be completed within the shortest time possible on the same day and no sooner than 24 hours after a significant precipitation event to minimize the precipitation effects on the data sets. Water level measurements will be recorded to the nearest 0.01 foot and referenced to a top-of-casing notch or northern side of the well casing. The measurement instrument will be decontaminated prior to conducting the measurement event and between each monitoring well.

14.1.6 MONITORING WELL SAMPLING

All groundwater samples will be collected from existing and newly installed monitoring wells using the procedures specified in USEPA SOP SESDPROC-301-R1 (Appendix B). Groundwater field parameters: dissolved oxygen, temperature, ORP, pH, specific conductance, and turbidity will be used to evaluate the aquifer and to determine when groundwater is representative of site conditions. Measurement of field parameters will be made using a multi-meter (to be selected at the time of the sampling event) and flow-through cells. Field equipment calibration procedures will be conducted as per manufacturer's instructions and USEPA SOPs including Field Measurement of Dissolved Oxygen (SESDPROC-106-R2), Field Temperature Measurement (SESDPROC-102-R3), Field Measurement of Oxidation-Reduction Potential (SESDPROC-113-RO, Field Measurement of pH (SESDPROC-10-R2), Field Specific Conductance Measurement (SESDPROC-101-R2 and Field Measurement of Turbidity (SESDPROC-103-R2).

Groundwater samples will be collected using a peristaltic pump and low flow/low stress sampling techniques. Following purging the monitoring well and the collection of samples for metals analysis, the tubing will be withdrawn and the groundwater sample for VOC analyses will be collected directly from the tubing that was inserted into the monitoring well using the straw or reverse flow method. Decontamination of the peristaltic pump and tubing will not be required because new Teflon® and silicon tubing will be used for each monitoring well.

If Light Non-Aqueous Phase Liquid (LNAPL) is detected in purge water initially being pumped from a monitoring well at any given location, its presence will be noted, and a groundwater sample will not be collected for laboratory analysis.

The groundwater samples will be placed in coolers, refrigerated with wet ice, and submitted under chain of custody protocol to a fixed-base laboratory for the parameters listed in Worksheet No. 15.

14.1.7 INVESTIGATION-DERIVED WASTE MANAGEMENT

It is anticipated that IDW materials will be generated during the field investigation, including aqueous fluids from decontamination, purge, and development water. These wastes must be disposed in such a manner that does not contribute to further environmental contamination or pose a threat to public health or safety. IDW will be handled in accordance with USEPA SOP SESDPROC-202-R2. Drums for storage of IDW will be provided by NAS Pensacola. Disposal of the IDW following receipt of the analytical data should be coordinated with NAS Pensacola.

14.1.8 FIELD DECONTAMINATION PROCEDURES

Decontamination of major equipment and sampling equipment used for monitoring well installation, soil sampling and groundwater sampling will be in general accordance with procedures described in USEPA SOP Field Equipment Cleaning and Decontamination (SESDPROC-205-R1). Sampling equipment will be decontaminated prior to and between sampling at each location. At each site, an abbreviated decontamination procedure consisting of a soapy water (laboratory-grade detergent) rinse, followed by a deionized (DI) water rinse will be performed. Decontamination fluids (IDW) will be collected in 5-gallon buckets and transferred into drums for disposal following the procedures listed in Section 14.1.7 (IDW Management).

14.1.9 FIELD DOCUMENTATION PROCEDURES

Pre-preserved, certified-clean bottle ware will be supplied by the laboratories. Matrix-specific sample log sheets will be maintained for each sample collected. In addition, sample collection information will be recorded in bound field notebooks or specific field forms. Samples will be packaged and shipped according to USEPA SOP Packing, Marking, Labeling and Shipping of Environmental and Waste Samples (SESDPROC-209-R2).

Field documentation will be performed in accordance with USEPA SOP Logbooks (SESDPROC-010-R4). A summary of all field activities will be properly recorded in indelible ink in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and will be stored in a secured area when not in use.

At a minimum, the following information will be recorded in the site logbook:

- Name of the person to whom the logbook is assigned.
- Project name.

- Project start date.
- Names and responsibilities of on-site project personnel including subcontractor personnel.
- Arrival/departure of site visitors.
- Arrival/departure of equipment.
- Sampling activities and sample log sheet references.
- Description of subcontractor activities.
- Sample pick-up information including chain-of-custody numbers, air bill numbers, carrier, time, and date.
- Health and safety issues.
- Description of photographs including date, time, photographer, roll and picture number, location, and compass direction of photograph.

All entries will be written in indelible ink and no erasures will be made. If an incorrect entry is made by striking a single line through the incorrect entry and initialing the change.

14.1.10 QUALITY CONTROL SAMPLES

Field QC samples will be collected at frequencies listed in Worksheet No. 12. Quality control of field sampling procedures will be performed in accordance with USEPA SOP Field Sampling and Quality Control (SESDPROC-011-R3).

14.1.11 ADDITIONAL PROJECT-RELATED TASKS

Additional project-related tasks include:

- Analytical tasks
- Data management
- Data review
- Project reports

Analytical Tasks

Dissolved gases (hydrogen, methane, ethane, ethene, nitrogen, and carbon dioxide) and CSIA will be performed by Microseeps. Microseeps is a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory for these analyses. A copy of Microseeps' accreditation can be found in Appendix C. (CSIA will be performed only during the third sampling event if, based on their

review of the first two sampling events, the NAS Pensacola Partnering Team decides such additional lines of evidence are necessary to support the efficacy of MNA.)

Microbial Insights will perform analysis for qPCR for dehalococcoides and reductase functional genes. No state or DoD accreditation is required for these analyses. The deliverable from Microbial insights will be in their own reporting format. (These analyses will be performed only during the third sampling event if, based on their review of the first two sampling events, the NAS Pensacola Partnering Team decides such additional lines of evidence are necessary to support the efficacy of MNA.)

Chemical analyses will be performed by Empirical and Columbia Analytical Services, which are DoD Environmental Laboratory Accreditation Program (ELAP)-accredited laboratories. A copy of Empirical's and Columbia Analytical Services' accreditation is included in Appendix C. Analyses will be performed in accordance with the analytical methods identified in Worksheet No. 19. Empirical will perform the chemical analyses following laboratory-specific SOPs (see Worksheets No. 19 and 23) developed based on the methods listed in Worksheet No. 30.

The analytical data packages provided by Empirical, Columbia Analytical Services, and Microseeps will be in a CLP-SOW-like format and will be fully validatable and contain raw data, summary forms for all sample and laboratory method blank data, and summary forms containing all method-specific QC [results, recoveries, RPDs, relative standard deviations (RSD), and/or percent differences, etc.].

Data Management

The principal data generated for this project will be from field data and laboratory analytical data. Field sampling log sheets will be organized by date and medium and filed in the project files. 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. Project personnel completing concurrent field sampling activities may maintain multiple field logbooks. When possible, logbooks will be segregated by sampling activity. The field logbooks will be titled based on date and activity.

The data handling procedures to be followed by the laboratories will meet the requirements of the technical specifications. Electronic data results will be automatically downloaded into the Tetra Tech database in accordance with the proprietary Tetra Tech processes.

The Tetra Tech PM (or designee) is responsible for the overall tracking and control of data generated for the project.

- **Data Tracking**. Data are tracked from generation to archiving in the Tetra Tech project-specific files. The Tetra Tech Project Chemist (or designee) is responsible for tracking the samples collected and shipped to the laboratories. Upon receipt of the data packages from the laboratories, the Tetra Tech Project Chemist will monitor the data validation effort, which includes verifying that the data packages are complete and results for all samples have been delivered by the laboratories.

- **Data Storage, Archiving, and Retrieval**. The data packages received from the laboratories are tracked in the data validation logbook. After the data are validated, the data packages are entered into the Tetra Tech Navy CLEAN 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 Tetra Tech FOL to be entered into the Navy CLEAN file system prior to archiving in secure project files. Project files are audited for accuracy and completeness. At the completion of the Navy contract, the records will be stored by Tetra Tech.

- **Data Security**. Access to Tetra Tech project files is restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. The Tetra Tech Data Manager maintains the electronic data files, and access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

- **Electronic Data**. All electronic data will be compiled into a Naval Installation Restoration Information Solution (NIRIS) Electronic Data Deliverable (NEDD) and loaded into NIRIS.

- **Data Review**. This review comprises data verification, validation, and usability assessment. The data verification and validation processes and requirements are described in Worksheets No. 34 to 36. The data usability assessment will, at a minimum, constitute evaluation of the following characteristics to ensure that the amount, type, and quality of data are sufficient to achieve project objectives. The means of conducting these evaluations will vary depending on the nature of the data. For example, soil borings and well construction logs will generally be evaluated qualitatively or semiquantitatively whereas precision, accuracy, and sensitivity of analytical data will generally be evaluated quantitatively and may be based on, or may supplement, data validation findings.

Project Reporting

A Technical Memorandum will be prepared after each sampling event to document the findings of the newly collected data, document the DQOs that were developed and describe the design of the future sampling event. In addition, at the completion of the three sampling events, an FS Addendum will be prepared to evaluate the efficacy of an MNA remedy and to compare MNA with other appropriate remedial alternatives.

SAP Worksheet No. 15 -- Reference Limits and Evaluation Table

(UFP-QAPP Manual Section 2.8.1)

Worksheet 15 list the analytes that will be analyzed during the first and second round of sampling as described in Worksheet 9. The PALs that are provided in Worksheet No. 15 were developed from USEPA and FDEP screening criteria that are summarized in Appendix D.

Matrix: Soil

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
TAL Metals							
ALUMINUM	**7429-90-5**	**2300**	**USEPA Protection of GW**	**2500**	**40**	**20**	10
ANTIMONY	7440-36-0	0.27	USEPA Protection of GW	1	2	1.6	1
ARSENIC	7440-38-2	0.0013	USEPA Protection of GW	0.009	2	1.2	0.6
BARIUM	7440-39-3	82	USEPA Protection of GW	40	8	4	1
BERYLLIUM	7440-41-7	3.2	USEPA Protection of GW	5	1	0.4	0.2
CADMIUM	**7440-43-9**	**0.38**	**USEPA Protection of GW**	**2**	**1**	**0.4**	**0.2**
CALCIUM	7440-70-2	NC	None	NC	1000	400	200
CHROMIUM[1]	7440-47-3	0.00059	USEPA Protection of GW	0.004	2	0.8	0.4
COBALT	7440-48-4	0.21	USEPA Protection of GW	0.8	2.5	2	1
COPPER	7440-50-8	150	Residential SCTL	50	2	1.6	0.8
IRON	7439-89-6	270	USEPA Protection of GW	1800	20	12	6
LEAD	7439-92-1	14	USEPA Protection of GW	130	1	0.6	0.3
MERCURY	**7439-97-6**	**0.033**	**USEPA Protection of GW**	**0.22**	**0.033**	**0.033**	**0.013**
MAGNESIUM	7439-95-4	NC	None	NC	1000	600	200
MANGANESE	7439-96-5	180	USEPA RSL	60	3	1.2	0.6

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NICKEL	7440-02-0	20	USEPA Protection of GW	43	2	1.2	0.6
POTASSIUM	7440-09-7	NC	None	NC	1000	600	200
SELENIUM	7782-49-2	0.26	USEPA Protection of GW	1.7	2	1	0.6
SILVER	**7440-22-4**	**0.6**	**USEPA Protection of GW**	**4**	**2**	**0.4**	**0.2**
SODIUM	7440-23-5	NC	None	NC	1000	600	200
THALLIUM	7440-28-0	0.14	USEPA Protection of GW	0.026	1.6	0.8	0.6
VANADIUM[2]	7440-62-2	78	USEPA Protection of GW	13	2.5	2	1
ZINC	7440-66-6	290	USEPA Protection of GW	760	4	2	1
Miscellaneous							
CHROMIUM (HEXAVALENT)	18540-29-9	0.00059	USEPA Protection of GW	0.1	0.4	0.2	0.065
TCL VOCs							
1,1- DICHLOROETHANE	75-34-3	0.00068	USEPA Protection of GW	0.004	0.005	0.0025	0.00125
1,1,1-TRICHLOROETHANE	71-55-6	0.07	USEPA Protection of GW	0.6	0.005	0.0025	0.00125
1,1,2- TRICHLOROETHANE	79-00-5	0.000077	USEPA Protection of GW	0.000513333	0.005	0.0025	0.00125
1,1,2,2- TETRACHLORETHANE	79-34-5	0.000026	USEPA Protection of GW	0.0005	0.005	0.0025	0.00125
1,1,2-TRICHLORO-1,2,2-TRIFLUORO-ETHANE	76-13-1	130	USEPA Protection of GW	860	0.01	0.005	0.0025
1,1-DICHLOROETHENE	75-35-4	0.0025	USEPA Protection of GW	0.02	0.005	0.0025	0.00125
1,2- DICHLOROBENZENE	95-50-1	0.27	USEPA Protection of GW	1.8	0.005	0.0025	0.00125
1,2- DICHLOROETHANE	107-06-2	0.000042	USEPA Protection of GW	0.00028	0.005	0.0025	0.00125
1,2,3-TRICHLOROBENZENE	87-61-6	0.015	USEPA Protection of GW	0.1	0.005	0.0025	0.00125
1,2,4-TRICHLOROBENZENE	**120-82-1**	**0.0029**	**USEPA Protection of GW**	**0.02**	**0.005**	**0.0025**	**0.00125**

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1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.00000014	USEPA Protection of GW	0.0000007	0.01	0.005	0.0025
1,2-DIBROMOETHANE	106-93-4	0.0000018	USEPA Protection of GW	0.000012	0.005	0.0025	0.00125
1,2-DICHLOROPROPANE	78-87-5	0.00013	USEPA Protection of GW	0.0009	0.005	0.0025	0.00125
1,3-DICHLOROBENZENE	541-73-1	7	Leachability SCTL	2.3	0.005	0.0025	0.00125
1,4- DICHLOROBENZENE	106-46-7	0.0004	USEPA Protection of GW	0.003	0.005	0.0025	0.00125
1,4-DIOXANE*	123-91-1	0.00014	USEPA Protection of GW	0.0009	0.00667	0.00333	0.00167
2-BUTANONE	78-93-3	1.0	USEPA Protection of GW	5.7	0.01	0.005	0.0025
2-HEXANONE	591-78-6	0.0079	USEPA Protection of GW	0.05	0.01	0.005	0.0025
4-METHYL-2-PENTANONE	108-10-1	0.23	USEPA Protection of GW	0.87	0.01	0.005	0.0025
ACETONE	67-64-1	2.4	USEPA Protection of GW	8.3	0.02	0.01	0.005
BENZENE	71-43-2	0.0002	USEPA Protection of GW	0.001	0.005	0.0025	0.00125
BROMOCHLOROMETHANE	74-97-5	0.021	USEPA Protection of GW	0.14	0.005	0.0025	0.00125
BROMODICHLOROMETHANE	75-27-4	0.000032	USEPA Protection of GW	0.0002	0.005	0.0025	0.00125
BROMOFORM	**75-25-2**	**0.0021**	**USEPA Protection of GW**	**0.01**	**0.005**	**0.0025**	**0.00125**
BROMOMETHANE	74-83-9	0.0018	USEPA Protection of GW	0.012	0.01	0.005	0.0025
CARBON DISULFIDE	75-15-0	0.21	USEPA Protection of GW	1.4	0.005	0.0025	0.00125
CARBON TETRACHLORIDE	56-23-5	0.00015	USEPA Protection of GW	0.001	0.005	0.0025	0.00125
CHLOROBENZENE	108-90-7	0.049	USEPA Protection of GW	0.033	0.005	0.0025	0.00125
CHLOROETHANE (ethyl chloride)	75-00-3	0.06	Leachability SCTL	0.02	0.01	0.005	0.0025
CHLOROFORM	67-66-3	0.000053	USEPA Protection of GW	0.00035	0.005	0.0025	0.00125
CHLOROMETHANE	**74-87-3**	**0.01**	**Leachability SCTL**	**0.0033**	**0.01**	**0.005**	**0.0025**
CIS-1,2- DICHLOROETHENE	156-59-2	0.0082	USEPA Protection of GW	0.055	0.005	0.0025	0.00125

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CIS-1,3- DICHLOROPROPENE[3]	10061-01-5	0.00015	USEPA Protection of GW	0.0007	0.005	0.0025	0.00125
CYCLOHEXANE	110-82-7	13	USEPA Protection of GW	87	0.005	0.0025	0.00125
DIBROMOCHLOROMETHANE	124-48-1	0.000039	USEPA Protection of GW	0.00026	0.005	0.0025	0.00125
DICHLORODIFLUOROMETHANE	75-71-8	0.3	USEPA Protection of GW	2	0.01	0.005	0.0025
ETHYLBENZENE	**100-41-4**	**0.0015**	**USEPA Protection of GW**	**0.01**	**0.005**	**0.0025**	**0.00125**
ISOPROPYLBENZENE (Cumene)	98-82-8	0.2	Leachability SCTL	0.067	0.005	0.0025	0.00125
METHYL ACETATE	79-20-9	3.2	USEPA Protection of GW	5.3	0.01	0.005	0.0025
METHYL TERT-BUTYL ETHER	**1634-04-4**	**0.0028**	**USEPA Protection of GW**	**0.019**	**0.005**	**0.0025**	**0.00125**
METHYLCYCLOHEXANE	108-87-2	NC	None	NC	0.005	0.0025	0.00125
METHYLENE CHLORIDE	**75-09-2**	**0.0025**	**USEPA Protection of GW**	**0.0067**	**0.01**	**0.005**	**0.0025**
STYRENE	100-42-5	0.11	USEPA Protection of GW	1.2	0.005	0.0025	0.00125
TETRACHLOROETHENE	**127-18-4**	**0.0023**	**USEPA Protection of GW**	**0.00022**	**0.005**	**0.0025**	**0.00125**
TOLUENE	108-88-3	0.5	Leachability SCTL	0.17	0.005	0.0025	0.00125
TOTAL XYLENES	1330-20-7	0.19	USEPA Protection of GW	0.067	0.015	0.0075	0.00375
TRANS-1,2- DICHLOROETHENE	156-60-5	0.025	USEPA Protection of GW	0.17	0.005	0.0025	0.00125
TRANS-1,3- DICHLOROPROPENE[3]	10061-01-5	0.00015	USEPA Protection of GW	0.0007	0.005	0.0025	0.00125
TRICHLOROETHENE	79-01-6	0.00016	USEPA Protection of GW	0.001	0.005	0.0025	0.00125
TRICHLOROFLUOROMETHANE	75-69-4	0.69	USEPA Protection of GW	4.6	0.01	0.005	0.0025
VINYL CHLORIDE	75-01-4	0.0000053	USEPA Protection of GW	0.00003	0.005	0.0025	0.00125
TCL SVOCs							
1,1'-BIPHENYL	92-52-4	0.0087	USEPA Protection of GW	0.058	0.333	0.167	0.0833
1,2,4,5-TETRACHLOROBENZENE	95-94-3	0.0058	USEPA Protection of GW	0.04	0.333	0.167	0.0833

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2,2-OXYBIS(1-CHLOROPROPANE)	108-60-1	0.00011	USEPA Protection of GW	0.0007	0.333	0.167	0.0833
2,3,4,6-TETRACHLOROPHENOL	58-90-2	1.1	USEPA Protection of GW	1.1	0.333	0.167	0.0833
2,4,5-TRICHLOROPHENOL	95-95-4	0.07	Leachability SCTL	0.02	0.333	0.167	0.0833
2,4,6-TRICHLOROPHENOL	88-06-2	0.013	USEPA Protection of GW	0.02	0.333	0.167	0.0833
2,4-DICHLOROPHENOL	120-83-2	0.003	Leachability SCTL	0.001	0.333	0.167	0.0833
2,4-DIMETHYLPHENOL	105-67-9	0.32	USEPA Protection of GW	0.57	1.33	0.667	0.333
2,4-DINITROPHENOL	51-28-5	0.034	USEPA Protection of GW	0.02	3.33	1.67	0.833
2,4-DINITROTOLUENE	121-14-2	0.00028	USEPA Protection of GW	0.0001	0.333	0.167	0.0833
2,6-DINITROTOLUENE	606-20-2	0.0004	Leachability SCTL	0.0001	0.333	0.167	0.0833
2-CHLORONAPHTHALENE	91-58-7	2.9	USEPA Protection of GW	19.3	0.333	0.167	0.0833
2-CHLOROPHENOL	95-57-8	0.057	USEPA Protection of GW	0.2	0.333	0.167	0.0833
2-METHYLNAPHTHALENE	**91-57-6**	**0.14**	**USEPA Protection of GW**	**0.9**	**0.333**	**0.167**	**0.0833**
2-METHYLPHENOL (o-Cresol)	**95-48-7**	**0.3**	**Leachability SCTL**	**0.1**	**0.333**	**0.167**	**0.0833**
2-NITROANILINE	88-74-4	0.062	USEPA Protection of GW	0.03	1.33	0.667	0.333
2-NITROPHENOL	88-75-5	NC	None	NC	0.333	0.167	0.0833
3,3'-DICHLOROBENZIDINE	91-94-1	0.00071	USEPA Protection of GW	0.001	0.333	0.167	0.0833
3-NITROANILINE	99-09-2	0.01	Leachability SCTL	0.003	1.33	0.667	0.333
4,6-DINITRO-2-METHYLPHENOL	534-52-1	0.002	USEPA Protection of GW	0.013	3.33	1.67	0.833
4-BROMOPHENYL-PHENYLETHER	101-55-3	NC	None	NC	0.333	0.167	0.0833
4-CHLORO-3-METHYLPHENOL	59-50-7	0.4	Leachability SCTL	0.13	0.333	0.167	0.0833
4-CHLOROANILINE	106-47-8	0.00013	USEPA Protection of GW	0.0009	0.333	0.167	0.0833
4-CHLOROPHENYL-PHENYL ETHER	7005-72-3	NC	None	NC	0.333	0.167	0.0833

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4-METHYLPHENOL (p-Cresol)	106-44-5	0.03	Leachability SCTL	0.01	0.333	0.167	0.0833
4-NITROANILINE	100-01-6	0.0014	USEPA Protection of GW	0.003	1.33	0.667	0.333
4-NITROPHENOL	100-02-7	0.3	Leachability SCTL	0.1	1.33	0.667	0.333
ACENAPHTHENE	83-32-9	2.1	Leachability SCTL	0.7	0.333	0.167	0.0833
ACENAPHTHYLENE	208-96-8	27	Leachability SCTL	9	0.333	0.167	0.0833
ANTHRACENE	120-12-7	4.2	USEPA Protection of GW	280	0.333	0.167	0.0833
ATRAZINE	1912-24-9	0.00017	USEPA Protection of GW	0.001	0.333	0.167	0.0833
BENZALDEHYDE	**100-52-7**	**0.33**	**USEPA Protection of GW**	**1.6**	**0.333**	**0.167**	**0.0833**
BENZO (A) ANTHRACENE*	56-55-3	0.01	USEPA Protection of GW	0.05	0.00667	0.00333	0.00167
BENZO (A) PYRENE*	**50-32-8**	**0.0035**	**USEPA Protection of GW**	**0.005**	**0.00667**	**0.00333**	**0.00167**
BENZO (B) FLUOROANTHENE*	205-99-2	0.035	USEPA Protection of GW	0.05	0.00667	0.00333	0.00167
BENZO (G,H,I) PERYLENE	191-24-2	2500	RES SCTL	56.7	0.333	0.167	0.0833
BENZO (K) FLUOROANTHENE	207-08-9	0.35	USEPA Protection of GW	0.5	0.333	0.167	0.0833
BIS(2-CHLOROETHOXY) METHANE	111-91-1	63	Leachability SCTL	0.07	0.333	0.167	0.0833
BIS-(2-CHLOROETHYL) ETHER	111-44-4	0.0000031	USEPA Protection of GW	0.000002	0.333	0.167	0.0833
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7	0.017	USEPA Protection of GW	0.11	0.333	0.167	0.0833
BUTYLBENZYLPHTHALATE	**85-68-7**	**0.2**	**USEPA Protection of GW**	**1.3**	**0.333**	**0.167**	**0.0833**
CAPROLACTAM	105-60-2	1.9	USEPA Migration to GW	12.7	0.333	0.167	0.0833
CARBAZOLE	**86-74-8**	**0.2**	**Leachability SCTL**	**0.067**	**0.333**	**0.167**	**0.0833**
CHRYSENE	218-01-9	1.1	USEPA Protection of GW	5	0.333	0.167	0.0833
DIBENZO (A,H)-ANTHRACENE*	53-70-3	0.011	USEPA Protection of GW	0.005	0.00667	0.00333	0.00167
DIBENZOFURAN	**132-64-9**	**0.11**	**USEPA Protection of GW**	**0.73**	**0.333**	**0.167**	**0.0833**

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DIETHYLPHTHALATE	84-66-2	4.7	USEPA Protection of GW	28.7	0.333	0.167	0.0833
DIMETHYLPHTHALATE	131-11-3	380	Leachability SCTL	126	0.333	0.167	0.0833
DI-N-BUTYLPHTHALATE	84-74-2	1.7	USEPA Protection of GW	11.3	0.333	0.167	0.0833
DI-N-OCTYLPHTHALATE	117-84-0	1700	Res SCTL	560	0.333	0.167	0.0833
FLUORANTHENE	206-44-0	70	USEPA Protection of GW	76.6	0.333	0.167	0.0833
FLUORENE	86-73-7	4	USEPA Protection of GW	26.7	0.333	0.167	0.0833
HEXACHLOROBENZENE	118-74-1	0.00053	USEPA Protection of GW	0.003	0.333	0.167	0.0833
HEXACHLOROBUTADIENE	87-68-3	0.0005	USEPA Protection of GW	0.003	0.333	0.167	0.0833
HEXACHLOROCYCLOPENTADIENE	77-47-4	0.07	USEPA Protection of GW	0.47	0.333	0.167	0.0833
HEXACHLOROETHANE	67-72-1	0.00048	USEPA Protection of GW	0.0032	0.333	0.167	0.0833
INDENO (1,2,3-CD)-PYRENE	**193-39-5**	**0.12**	**USEPA Protection of GW**	**0.05**	**0.333**	**0.167**	**0.0833**
ISOPHORONE	78-59-1	0.022	USEPA Protection of GW	0.067	0.333	0.167	0.0833
NAPHTHALENE*	91-20-3	0.00047	USEPA Protection of GW	0.003	0.00667	0.00333	0.00167
NITROBENZENE	98-95-3	0.000079	USEPA Protection of GW	0.0005	0.333	0.167	0.0833
N-NITROSO DIPHENYLAMINE	86-30-6	0.057	USEPA Protection of GW	0.13	0.333	0.167	0.0833
N-NITROSO-DI-N PROPYLAMINE	621-64-7	0.000007	USEPA Protection of GW	0.000017	0.333	0.167	0.0833
PENTACHLOROPHENOL	87-86-5	0.0017	USEPA Protection of GW	0.01	1.33	0.667	0.333
PHENANTHRENE	85-01-8	250	Leachability SCTL	56.7	0.333	0.167	0.0833
PHENOL	108-95-2	0.05	Leachability SCTL	0.017	0.333	0.167	0.0833
PYRENE	129-00-0	9.5	USEPA Protection of GW	56.7	0.333	0.167	0.0833
TCL Pesticides							
4,4'-DDD	72-54-8	0.066	USEPA Protection of GW	0.44	0.00067	0.00034	0.00017

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4,4'-DDE	72-55-9	0.046	USEPA Protection of GW	0.31	0.00067	0.00034	0.00017
4,4'-DDT	50-29-3	0.067	USEPA Protection of GW	0.45	0.00067	0.00034	0.00017
ALDRIN	309-00-2	0.000034	USEPA Protection of GW	0.00023	0.00067	0.00034	0.00011
ALPHA-BHC	319-84-6	0.000036	USEPA Protection of GW	0.0001	0.00067	0.00034	0.00011
ALPHA-CHLORDANE[4]	5103-71-9	0.0018	USEPA Protection of GW	0.087	0.00067	0.00034	0.00011
BETA-BHC	**319-85-7**	**0.00013**	**USEPA Protection of GW**	**0.0003**	**0.00067**	**0.00034**	**0.00011**
DELTA-BHC	319-86-8	0.2	Leachability SCTL	0.067	0.00067	0.00034	0.00011
DIELDRIN	60-57-1	0.000061	USEPA Protection of GW	0.0004	0.00067	0.00034	0.00017
ENDOSULFAN I[5]	959-98-8	1.1	USEPA Protection of GW	1.3	0.00067	0.00034	0.00011
ENDOSULFAN II[5]	33213-65-9	1.1	USEPA Protection of GW	1.3	0.00067	0.00034	0.00017
ENDOSULFAN SULFATE[5]	1031-07-8	1.1	USEPA Protection of GW	1.3	0.00067	0.00034	0.00017
ENDRIN[6]	72-20-8	0.068	USEPA Protection of GW	0.33	0.00067	0.00034	0.00017
ENDRIN ALDEHYDE[6]	7421-93-4	0.068	USEPA Protection of GW	0.33	0.00067	0.00034	0.00017
ENDRIN KETONE[6]	53494-70-5	0.068	USEPA Protection of GW	0.33	0.00067	0.00034	0.00017
GAMMA-BHC (LINDANE)	**58-89-9**	**0.00021**	**USEPA Protection of GW**	**0.0014**	**0.00067**	**0.00034**	**0.00011**
GAMMA-CHLORDANE[4]	5103-74-2	0.0018	USEPA Protection of GW	0.087	0.00067	0.00034	0.00011
HEPTACHLOR	**76-44-8**	**0.00014**	**USEPA Migration to GW**	**0.0009**	**0.00067**	**0.00034**	**0.00011**
HEPTACHLOR EPOXIDE	1024-57-3	0.000068	USEPA Protection of GW	0.0004	0.00067	0.00034	0.00011
METHOXYCHLOR	72-43-5	1.5	USEPA Protection of GW	10	0.00067	0.00034	0.00011
TOXAPHENE	8001-35-2	0.0021	USEPA Protection of GW	0.014	0.033	0.022	0.011
TCL PCBs							
AROCLOR-1016	12674-11-2	0.092	USEPA Protection of GW	0.13	0.0167	0.00833	0.00417

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AROCLOR-1221	11104-28-2	0.000074	USEPA Protection of GW	0.0005	0.0167	0.00833	0.00417
AROCLOR-1232	11141-16-5	0.000074	USEPA Protection of GW	0.0005	0.0167	0.00833	0.00417
AROCLOR-1242	**53469-21-9**	**0.0053**	**USEPA Protection of GW**	**0.035**	**0.0167**	**0.00833**	**0.00417**
AROCLOR-1248	**12672-29-6**	**0.0052**	**USEPA Protection of GW**	**0.035**	**0.0167**	**0.00833**	**0.00417**
AROCLOR-1254	**11097-69-1**	**0.0088**	**USEPA Protection of GW**	**0.037**	**0.0167**	**0.00833**	**0.00417**
AROCLOR-1260	11096-82-5	0.024	USEPA Protection of GW	0.073	0.0167	0.00833	0.00417
TOTAL AROCLOR	1336-36-3	0.5	Res SCTL	0.17	0.0167	0.00833	0.00417

Notes:
The PAL references for soil are the minimum of: Soil Contaminant Target Level, F.A.C. 62-777 Residential Soil-Direct Exposure (Res SCTL) and Leachability to Groundwater Criteria (Leachability SCTL), Table II (FDEP, 2005); USEPA RSL: USEPA Regions 3, 6, and 9 Regional Screening Level for Soil, Residential (USEPA, May 2012); USEPA Protection of GW: USEPA Regions 3, 6, and 9 Regional Screening Level for Protection of Groundwater Risk-Based SSL using a dilution attenuation factor of 1 (USEPA, May 2012).

Bolded rows indicate that the PAL is between the laboratory LOQ and DL. The Partnering Team has agreed to accept this data for decision making if results below the LOQ are "J" qualified and the results are discussed in the monitoring report.

Shaded rows indicate the PAL is less than the DL; therefore, the Partnering Team has agreed to replace the PALs with the laboratory LOQs for decision making purposes, as suggested in “Guidance for the Selection of Analytical Methods for the Evaluation of Practical Quantitation Limits” (FDEP, 2004).

1) The value for hexavalent chromium is presented
2) The value presented is for Vanadium and compounds.
3) The value for 1,3-dichloropropene is presented.
4) The value for Chlordane is presented.
5) The value for Endosulfan is presented.
6) The value for Endrin is presented.

* indicates that these compounds will be reported from a low level scan analysis.
LOD – Limit of Detection; LOQ – Limit of Quantitation; DL – Detection Limit.

Matrix: Water

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
TAL Metals							
ALUMINUM	7429-90-5	200	SMCL	66.7	50	25	12.5
ANTIMONY	7440-36-0	0.6	Tapwater RSL	0.2	2.5	2	1.25
ARSENIC	7440-38-2	0.045	Tapwater RSL	0.015	2.5	1.5	0.75
BARIUM	7440-39-3	290	Tapwater RSL	96.7	10	2.5	1.25
BERYLLIUM	7440-41-7	1.6	Tapwater RSL	0.53	1.25	0.5	0.25
CADMIUM	**7440-43-9**	**0.69**	**Tapwater RSL**	**0.23**	**1.25**	**0.5 0.25**	
CALCIUM	7440-70-2	NC	None	None	1250	500	250
CHROMIUM[1]	7440-47-3	0.031	Tapwater RSL	0.01	2.5	1	0.5
COBALT	7440-48-4	0.47	Tapwater RSL	0.16	3.125	2.5	1.25
COPPER	7440-50-8	62	Tapwater RSL	20.7	2.5	2	1
IRON	7439-89-6	300	GCTL	100	25	15	7.5
LEAD	7439-92-1	15	GCTL/Tapwater RSL	5	0.75	0.75	0.375
MERCURY	7439-97-6	0.063	Tapwater RSL	0.021	0.2	0.2	0.08
MAGNESIUM	7439-95-4	NC	None	None	1250	750	250
MANGANESE	7439-96-5	32	Tapwater RSL	10.7	3.75	1.5	0.75
NICKEL	7440-02-0	30	Tapwater RSL	10	2.5	1.5	0.75
POTASSIUM	7440-09-7	NC	None	None	1250	750	250
SELENIUM	7782-49-2	7.8	Tapwater RSL	2.6	2.5	1.25	0.75
SILVER	7440-22-4	7.1	Tapwater RSL	2.4	2.5	0.5	0.25
SODIUM	7440-23-5	160000	GCTL	53000	1250	750	250
THALLIUM	7440-28-0	0.016	Tapwater RSL	0.005	2	1	0.75
VANADIUM[2]	7440-62-2	7.8	Tapwater RSL	2.6	3.125	2.5	1.25
ZINC	7440-66-6	470	Tapwater RSL	157	5	2.5	1.25
Miscellaneous							
Hexavalent Chromium	18540-29-9	0.031	Tapwater RSL	0.01	0.02	0.01	0.009
TCL VOCs							
1,1-DICHLOROETHANE	75-34-3	2.4	Tapwater RSL	0.8	1	0.5	0.25
1,1,1-TRICHLOROETHANE	71-55-6	200	GCTL	66.7	1	0.5	0.25
1,1,2-TRICHLOROETHANE	79-00-5	0.024	Tapwater RSL	0.014	1	0.5	0.25

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
1,1,2,2-TETRACHLOROETHANE	79-34-5	0.066	Tapwater RSL	0.022	1	0.5	0.25
1,1,2-TRICHLORO-1,2,2-TRIFLUORO-ETHANE	76-13-1	5300	Tapwater RSL	1770	2	1	0.5
1,1-DICHLOROETHENE	75-35-4	7	GCTL	2.3	1	0.5	0.25
1,2-DICHLOROBENZENE	95-50-1	28	Tapwater RSL	9.3	1	0.5	0.25
1,2-DICHLOROETHANE	107-06-2	0.15	Tapwater RSL	0.05	1	0.5	0.25
1,2,3-TRICHLOROBENZENE	**87-61-6**	**0.52**	**Tapwater RSL**	**0.17**	**1**	**0.5**	**0.25**
1,2,4-TRICHLOROBENZENE	**120-82-1**	**0.99**	**Tapwater RSL**	**0.13**	**1**	**0.5**	**0.25**
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.00032	Tapwater RSL	0.0001	2	1	0.5
1,2-DIBROMOETHANE	106-93-4	0.0065	Tapwater RSL	0.0022	1	0.5	0.25
1,2-DICHLOROPROPANE	**78-87-5**	**0.38**	**Tapwater RSL**	**0.13**	**1**	**0.5**	**0.25**
1,3-DICHLOROBENZENE	541-73-1	210	GCTL	70	1	0.5	0.25
1,4-DICHLOROBENZENE	**106-46-7**	**0.42**	**Tapwater RSL**	**0.14**	**1**	**0.5**	**0.25**
1,4-DIOXANE	123-91-1	0.67	Tapwater RSL	0.22	40	20	10
2-BUTANONE	78-93-3	490	Tapwater RSL	163	10	5	2.5
2-HEXANONE	**591-78-6**	**3.4**	**Tapwater RSL**	**1.1**	**5**	**2.5**	**1.25**
4-METHYL-2-PENTANONE	108-10-1	100	Tapwater RSL	33.3	5	2.5	1.25
ACETONE	67-64-1	1200	Tapwater RSL	400	10	5	2.5
BENZENE	**71-43-2**	**0.39**	**Tapwater RSL**	**0.13**	**1**	**0.5**	**0.25**
BROMOCHLOROMETHANE	74-97-5	8.3	Tapwater RSL	2.8	1	0.5	0.25
BROMODICHLOROMETHANE	75-27-4	0.12	Tapwater RSL	0.04	1	0.5	0.25
BROMOFORM	75-25-2	4.4	GCTL	1.5	1	0.5	0.25
BROMOMETHANE	**74-83-9**	**0.7**	**Tapwater RSL**	**0.23**	**2**	**1**	**0.5**
CARBON DISULFIDE	75-15-0	72	Tapwater RSL	24	1	0.5	0.25
CARBON TETRACHLORIDE	**56-23-5**	**0.39**	**Tapwater RSL**	**0.13**	**1**	**0.5**	**0.25**
CHLOROBENZENE	108-90-7	7.2	Tapwater RSL	2.4	1	0.5	0.25
CHLOROETHANE	75-00-3	12	GCTL	4	2	1	0.5
CHLOROFORM	67-66-3	0.19	Tapwater RSL	0.063	1	0.5	0.25
CHLOROMETHANE	74-87-3	2.7	GCTL	0.9	1	0.5	0.25
CIS-1,2-DICHLOROETHENE	156-59-2	2.8	Tapwater RSL	0.93	1	0.5	0.25
CIS-1,3-DICHLOROPROPENE[3]	**10061-01-5**	**0.41**	**Tapwater RSL**	**0.14**	**1**	**0.5**	**0.25**
CYCLOHEXANE	110-82-7	1300	Tapwater RSL	433	1	0.5	0.25
DIBROMOCHLOROMETHANE	124-48-1	0.15	Tapwater RSL	0.05	1	0.5	0.25

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
DICHLORODIFLUOROMETHANE	75-71-8	19	Tapwater RSL	6.3	2	1	0.5
ETHYLBENZENE	100-41-4	1.3	Tapwater RSL	0.43	1	0.5	0.25
ISOPROPYLBENZENE (Cumene)	**98-82-8**	**0.8**	**GCTL**	**0.27**	**1**	**0.5**	**0.25**
METHYL ACETATE	79-20-9	1600	Tapwater RSL	533	2	1	0.5
METHYL TERT-BUTYL ETHER	1634-04-4	12	Tapwater RSL	4	1	0.5	0.25
METHYL CYCLOHEXANE	108-87-2	NC	None	None	1	0.5	0.25
METHYLENE CHLORIDE	75-09-2	5	MCL	1.6	2	1	0.5
STYRENE	100-42-5	100	MCL	33.3	1	0.5	0.25
TETRACHLOROETHENE	127-18-4	3	MCL	0.024	1	0.5	0.25
TOLUENE	108-88-3	40	GCTL	13.3	1	0.5	0.25
O-XYLENE	95-94-6	19	Tapwater RSL	6.3	1	0.5	0.25
m,p-XYLENE	179601-23-1	19	Tapwater RSL	6.3	2	1	0.5
TOTAL XYLENES	1330-20-7	19	Tapwater RSL	6.3	3	1.5	0.75
TRANS-1,2-DICHLOROETHENE	156-60-5	8.6	Tapwater RSL	2.9	1	0.5	0.25
TRANS-1,3-DICHLOROPROPENE[3]	**10061-02-6**	**0.41**	**Tapwater RSL**	**0.14**	**1**	**0.5**	**0.25**
TRICHLOROETHENE	**79-01-6**	**0.44**	**Tapwater RSL**	**0.087**	**1**	**0.5**	**0.25**
TRICHLOROFLUOROMETHANE	75-69-4	110	Tapwater RSL	36.7	2	1	0.5
VINYL CHLORIDE	75-01-4	0.015	Tapwater RSL	0.005	1	0.5	0.25
TCL SVOCs							
1,1'-BIPHENYL	92-52-4	0.083	Tapwater RSL	0.028	5	2.5	1.25
1,2,4,5-TETRACHLOROBENZENE	95-94-3	0.12	Tapwater RSL	0.04	5	2.5	1.25
2,2-OXYBIS(1-CHLOROPROPANE)	108-60-1	0.31	Tapwater RSL	0.1	5	2.5	1.25
2,3,4,6-TETRACHLOROPHENOL	58-90-2	17	Tapwater RSL	5.7	5	2.5	1.25
2,4,5-TRICHLOROPHENOL	95-95-4	1	GCTL	0.33	5	2.5	1.25
2,4,6-TRICHLOROPHENOL	88-06-2	3.2	GCTL	0.3	5	2.5	1.25
2,4-DICHLOROPHENOL	120-83-2	3.5	GCTL	0.1	5	2.5	1.25
2,4-DIMETHYLPHENOL	105-67-9	27	Tapwater RSL	9	20	10	5
2,4-DINITROPHENOL	51-28-5	3	Tapwater RSL	1	50	25	8.33
2,4-DINITROTOLUENE	121-14-2	0.05	GCTL	0.017	5	2.5	1.25
2,6-DINITROTOLUENE	606-20-2	0.05	GCTL	0.017	5	2.5	1.25
2-CHLORONAPHTHALENE	91-58-7	55	Tapwater RSL	18.3	5	2.5	1.25
2-CHLOROPHENOL	95-57-8	7.1	Tapwater RSL	2.4	5	2.5	1.25
2-METHYLNAPHTHALENE*	91-57-6	2.7	Tapwater RSL	0.9	0.2	0.1	0.05

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2-METHYLPHENOL	95-48-7	35	GCTL	11.7	5	2.5	1.25
2-NITROANILINE	**88-74-4**	**15**	**Tapwater RSL**	**5**	**20**	**10**	**5**
2-NITROPHENOL	88-75-5	NC	None	None	5	2.5	1.25
3,3'-DICHLOROBENZIDINE	91-94-1	0.08	GCTL	0.027	5	2.5	1.25
3-NITROANILINE[4]	99-09-2	1.7	GCTL	0.57	20	10	5
4,6-DINITRO-2-METHYLPHENOL	534-52-1	0.12	Tapwater RSL	0.04	20	10	5
4-BROMOPHENYL-PHENYLETHER	101-55-3	NC	None	None	5	2.5	1.25
4-CHLORO-3-METHYLPHENOL	59-50-7	63	GCTL	21	5	2.5	1.25
4-CHLOROANILINE	106-47-8	0.32	Tapwater RSL	0.1	5	2.5	1.25
4-CHLOROPHENYL-PHENYL ETHER	7005-72-3	NC	None	None	5	2.5	1.25
4-METHYLPHENOL	**106-44-5**	**3.5**	**GCTL**	**1.2**	**5**	**2.5**	**1.25**
4-NITROANILINE	100-01-6	1.7	GCTL	0.57	20	10	5
4-NITROPHENOL	100-02-7	56	GCTL	18.7	20	10	5
ACENAPHTHENE*	83-32-9	20	GCTL	6.7	0.2	0.1	0.05
ACENAPHTHYLENE*	208-96-8	40	Tapwater RSL	13.3	0.2	0.1	0.05
ANTHRACENE*	120-12-7	130	Tapwater RSL	43.3	0.2	0.1	0.05
ATRAZINE	1912-24-9	0.26	Tapwater RSL	0.087	5	2.5	1.25
BENZALDEHYDE	100-52-7	150	Tapwater RSL	50	5	2.5	1.25
BENZO(A)ANTHRACENE*	56-55-3	0.029	Tapwater RSL	0.0097	0.2	0.1	0.05
BENZO(A)PYRENE*	50-32-8	0.0029	Tapwater RSL	0.00097	0.2	0.1	5
BENZO(B)FLUORANTHENE*	205-99-2	0.029	Tapwater RSL	0.0097	0.2	0.1	0.05
BENZO(G,H,I)PERYLENE*[5]	191-24-2	8.7	Tapwater RSL	2.9	0.2	0.1	0.05
BENZO(K)FLUORANTHENE*	207-08-9	0.29	Tapwater RSL	0.097	0.2	0.1	0.05
BIS(2-CHLOROETHOXY)METHANE	**111-91-1**	**4.7**	**Tapwater RSL**	**1.6**	**5**	**2.5**	**1.25**
BIS(2-CHLOROETHYL)ETHER	111-44-4	0.012	Tapwater RSL	0.004	5	2.5	1.25
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	0.071	Tapwater RSL	0.024	5	2.5	1.25
BUTYLBENZYLPHTHALATE	85-68-7	14	Tapwater RSL	4.7	5	2.5	1.25
CAPROLACTAM	105-60-2	770	Tapwater RSL	257	5	2.5	1.25
CARBAZOLE	**86-74-8**	**1.8**	**GCTL**	**0.6**	**5**	**2.5**	**1.25**
CHRYSENE*	218-01-9	2.9	Tapwater RSL	1	0.2	0.1	0.05
DIBENZO(A,H)ANTHRACENE*	53-70-3	0.0029	Tapwater RSL	0.00097	0.2	0.1	0.05
DIBENZOFURAN	132-64-9	0.58	Tapwater RSL	0.19	5	2.5	1.25

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
DIETHYL PHTHALATE	84-66-2	1100	Tapwater RSL	367	5	2.5	1.25
DIMETHYL PHTHALATE	131-11-3	70000	GCTL	23000	5	2.5	1.25
DI-N-BUTYL PHTHALATE	84-74-2	67	Tapwater RSL	22.3	5	2.5	1.25
DI-N-OCTYL PHTHALATE	117-84-0	140	GCTL	46.7	5	2.5	1.25
FLUORANTHENE*	206-44-0	63	Tapwater RSL	21	0.2	0.1	0.05
FLUORENE*	86-73-7	22	Tapwater RSL	7.3	0.2	0.1	0.05
HEXACHLOROBENZENE	118-74-1	0.042	Tapwater RSL	0.014	5	2.5	1.25
HEXACHLOROBUTADIENE	87-68-3	0.26	Tapwater RSL	0.087	5	2.5	1.25
HEXACHLOROCYCLOPENTADIENE	**77-47-4**	**2.2**	**Tapwater RSL**	**0.73**	**5**	**2.5**	**1.25**
HEXACHLOROETHANE	67-72-1	0.79	Tapwater RSL	0.17	5	2.5	1.25
INDENO(1,2,3-CD)PYRENE*	193-39-5	0.029	Tapwater RSL	0.0097	0.2	0.1	0.05
ISOPHORONE	78-59-1	37	GCTL	12.3	5	2.5	1.25
NAPHTHALENE*	**91-20-3**	**0.14**	**Tapwater RSL**	**0.047**	**0.2**	**0.1**	**0.05**
NITROBENZENE	98-95-3	0.12	Tapwater RSL	0.04	5	2.5	1.25
N-NITROSODIPHENYLAMINE	86-30-6	7.1	GCTL	2.4	5	2.5	1.25
N-NITROSO-DI-N-PROPYLAMINE	621-64-7	0.005	GCTL	0.0017	5	2.5	1.25
PENTACHLOROPHENOL	87-86-5	0.17	Tapwater RSL	0.057	20	10	5
PHENANTHRENE*[5]	85-01-8	8.7	Tapwater RSL	2.9	0.2	0.1	0.05
PHENOL	108-95-2	10	GCTL	3.3	5	2.5	1.25
PYRENE*	129-00-0	8.7	Tapwater RSL	2.9	0.2	0.1	0.05
TCL Pesticides							
4,4'-DDD	72-54-8	0.1	GCTL	0.033	0.02	0.01	0.005
4,4'-DDE	72-55-9	0.1	GCTL	0.033	0.02	0.01	0.005
4,4'-DDT	50-29-3	0.1	GCTL	0.033	0.02	0.01	0.005
ALDRIN	309-00-2	0.00021	Tapwater RSL	0.00007	0.02	0.01	0.0033
ALPHA-BHC	**319-84-6**	**0.006**	**GCTL**	**0.002**	**0.02**	**0.01**	**0.0033**
ALPHA-CHLORDANE[6]	5103-71-9	0.027	Tapwater RSL	0.063	0.02	0.01	0.0033
BETA-BHC	319-85-7	0.02	GCTL	0.0067	0.02	0.01	0.0033
DELTA-BHC	319-86-8	2.1	GCTL	0.7	0.02	0.01	0.0033
DIELDRIN	60-57-1	0.0015	Tapwater RSL	0.0005	0.02	0.01	0.005
ENDOSULFAN I[7]	959-98-8	7.8	Tapwater RSL	0.26	0.02	0.01	0.0033
ENDOSULFAN II[7]	33213-65-9	78	Tapwater RSL	0.26	0.02	0.01	0.005
ENDOSULFAN SULFATE[7]	1031-07-8	7.8	Tapwater RSL	0.26	0.02	0.01	0.005

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ENDRIN[8]	72-20-8	0.17	Tapwater RSL	0.057	0.02	0.01	0.005
ENDRIN ALDEHYDE[8]	7421-93-4	0.17	Tapwater RSL	0.057	0.02	0.01	0.005
ENDRIN KETONE[8]	53494-70-5	0.17	Tapwater RSL	0.057	0.02	0.01	0.005
GAMMA-BHC (LINDANE)	58-89-9	0.036	Tapwater RSL	0.012	0.02	0.01	0.0033
GAMMA-CHLORDANE[6]	5103-74-2	0.027	Tapwater RSL	0.063	0.02	0.01	0.0033
HEPTACHLOR	76-44-8	0.0018	Tapwater RSL	0.0006	0.02	0.01	0.0033
HEPTACHLOR EPOXIDE	**1024-57-3**	**0.0033**	**Tapwater RSL**	**0.0011**	**0.02**	**0.01**	**0.0033**
METHOXYCHLOR	72-43-5	2.7	Tapwater RSL	0.9	0.02	0.01	0.0033
TOXAPHENE	8001-35-2	0.013	Tapwater RSL	0.0043	1	0.667	0.33
TCL PCBs							
AROCLOR-1016	12674-11-2	0.096	Tapwater RSL	0.037	0.5	0.25	0.125
AROCLOR-1221	11104-28-2	0.0043	Tapwater RSL	0.0014	0.5	0.25	0.125
AROCLOR-1232	11141-16-5	0.0043	Tapwater RSL	0.0014	0.5	0.25	0.125
AROCLOR-1242	53469-21-9	0.034	Tapwater RSL	0.011	0.5	0.25	0.125
AROCLOR-1248	12672-29-6	0.034	Tapwater RSL	0.011	0.5	0.25	0.125
AROCLOR-1254	11097-69-1	0.034	Tapwater RSL	0.01	0.5	0.25	0.125
AROCLOR-1260	11096-82-5	0.034	Tapwater RSL	0.011	0.5	0.25	0.125
TOTAL AROCLOR	1336-36-3	0.5	GCTL	0.17	3.5	1.75	0.875

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)

Notes:
1) The value for hexavalent chromium is presented
2) The value presented is for Vanadium and compounds.
3) The value for 1,3-dichloropropene is presented.
4) The value for 4-nitroaniline is presented.
5) The value for pyrene is presented.
6) The value for Chlordane is presented.
7) The value for Endosulfan is presented.
8) The value for Endrin is presented.

* indicates that these compounds will be reported from a low level scan analysis.

Project Action Limits include:

- Federal Maximum Contaminant Levels (MCLs) per the 1974 Safe Drinking Water Act, amended in 1986 and 1996.
- Florida Maximum Contaminant Levels (MCLs) per Chapter 62-550, Florida Administrative Code (F.A.C.), Secondary Criteria (SMCL) and Primary Criteria (PMCL); and Florida Groundwater Cleanup Target Levels (GCTLs) per Chapter 62-777, F.A.C.
- USEPA Regional Screening Levels (RSLs) (May, 2012) include Tap Water RSLs for noncarcinogens adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The tap water RSL for carcinogens (not adjusted) is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

Bolded rows indicate that the PAL is between the laboratory LOQ and DL. The Partnering Team has agreed to accept this data for decision making if results below the LOQ are "J" qualified and the results are discussed in the monitoring report.

Shaded rows indicate the PAL is less than the DL; therefore, the Partnering Team has agreed to replace the PALs with the laboratory LOQs for decision making purposes, as suggested in “Guidance for the Selection of Analytical Methods for the Evaluation of Practical Quantitation Limits” (FDEP, 2004).

SAP Worksheet No. 16 -- Schedule/Timeline

See Appendix E for current GANT Schedule/Chart.

SAP Worksheet No. 17 -- Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

The following presents a Proposed Field Work Plan that was revised from the one developed during the DQO Meeting (Worksheet No. 9) and based on comments received from the USEPA and FDEP (Appendix G).

Round 1:

- Collect a synoptic round of water levels and total depth measurements for all existing monitoring wells and the sewer grates will be examined for evidence of water flow.
- Collect groundwater samples from all existing monitoring wells and analyze for the parameters as listed in Worksheets No. 15 and 18.
- Conduct three soil borings (grassed area adjacent to Building 3629) with a stainless steel hand auger to collect soil samples (Worksheet No. 14) for the parameters as listed in Worksheets No. 15 and 18.
- A meeting will be held to discuss the results of the first round of sampling and select monitoring well cluster locations and the analyte list for Round 2. The analytes listed in Worksheet No. 18 will be revised based on this meeting.

Round 2A:

- Four borings will be conducted (1 upgradient, 2 along the spine of the plume, and 1 down gradient) to determine lithology, screen for VOCs, and determine appropriate screen intervals for well clusters to subsequently be completed at the four boring locations.
- A stainless steel hand auger will be used to collect soil samples for field screening of VOCs while clearing the four boring locations for the presence of utilities (please refer to Worksheet No. 14 for the screening methodology).
- The four borings will be completed to the clay layer (~70 feet) and lithologic information will be collected. Groundwater samples will be collected with a hydropunch at 5-foot intervals and screened with AQR Color-Tec®.
- Well clusters will be completed at the four boring locations. The hydraulic upgradient and downgradient monitoring well cluster locations will each include a shallow, intermediate, and deep well. The two in-plume monitoring well cluster locations will include intermediate and

deep wells that are expected to be co-located with existing shallow monitoring wells. The two shallow monitoring wells that will be installed in the upgradient and downgradient well clusters will have well screens placed across the water table at a depth similar to the other existing shallow monitoring wells and the four intermediate and four deep monitoring wells will be screened based on lithologic and VOC screening information described above.

- A round of synoptic water levels and total depth measurements will be collected and the sewer grates will be examined for evidence of water flow.

Round 2B:

- New shallow, intermediate and deep monitoring wells to be sampled and the analyte list will include TCL and TAL parameters (Worksheet No. 15) and additional parameters, if any, as provided in Revision 1 of Worksheet No. 18.

- Existing monitoring wells to be sampled and the analyte list will be determined based on the data from Round 1 (Revision 1 of Worksheet No. 18).

- A meeting will be held to discuss the results of the second round of sampling. The analytes listed in Revision 1 of Worksheet No. 18 will be revised based on this meeting.

Round 3:

- Existing and new monitoring wells to be sampled and the analyte list will be determined based on the data from Rounds 1 and 2 (Revision 2 of Worksheet No. 18).

- If deemed necessary by the Team based on the analytical results from Rounds 1 and 2, additional technologies (qPCR for *Dehalococcoides* and functional reductase genes, CSIA, and SIP) may be utilized.

- A meeting will be held to discuss the results of all the sampling and a scoping meeting will be held to determine document content and submittal.

Soil Sampling

The proposed sampling locations, rationale, and analytes for soil samples are presented in Worksheet No. 18. USEPA requested that soil samples be collected at three locations, one north of the foundation for former Building 3629 (hydraulically sidegradient or upgradient of the TCE plume) and two southeast of the foundation for former Building 3629 (hydraulically upgradient of the TCE plume). The three soil sample locations are shown in Figure 17-1. The purpose of the additional soil samples is to supplement the existing TCL/TAL soil sample results in the RI and provide information to confirm that the

grassed area is not a source for the analytes detected in groundwater, confirm direct soil exposure human health by comparison of the analytical results to PALs (including hexavalent chromium based on revision to USEPA RSLs) and assess the potential for a contaminant(s) to leach to groundwater.

Speciation of chromium will also be conducted per USEPA's memorandum dated September 30, 2011 because the maximum detected concentration of chromium (15.3 mg/kg) at Site 44 exceeds two times the NAS Pensacola background concentration. For soil, speciation of chromium will be conducted only for the surface soil sample interval collected at the three soil boring locations.

Groundwater Sampling

Three quarterly monitoring events will be conducted in the area of the known TCE groundwater plume. Worksheet No. 18 describes the parameters that will be analyzed for the first sampling event. Worksheet No. 18 will be revised by the Partnering Team for each subsequent event based on the first and subsequent rounds of analytical results. Worksheet No. 11 describes the process the Partnering Team will follow for determining the analytes that will be analyzed during the second and third sampling events. The process for selecting the analytes was based on the DQO meeting (Worksheet 9) and subsequent comments received from the USEPA and FDEP (Appendix G). The existing monitoring wells to be sampled during the first of three quarterly monitoring events are presented in Figures 17-2 and 17-3. The field QC samples required are specified in Worksheet No. 12.

Groundwater levels will be measured during each monitoring event in all monitoring wells to determine the groundwater flow direction. To monitor the potential for groundwater to infiltrate storm sewers, the storm water drains at Site 44 will be visually inspected to determine if water is present and visibly flowing during periods of no rainfall. Groundwater samples will be collected during each monitoring event using the USEPA SOP SESDPROC-301-R1 for “low flow, low stress” sampling and submitted to an off-site laboratory for analysis.

USEPA requested by Email (dated Monday, January 30, 2012) that select monitoring wells will be analyzed for TCL and TAL analytes. The list of wells and rationale include:

- PEN-3221-03: former UST well; previously reported manganese above screening criteria.
- PEN-3221-04: located immediately downgradient of former UST.
- PEN-3221-06: located just outside southwest corner of Building 3221; previously reported naphthalene above the tapwater RSL.

- PEN-3221-09: TCE detected above screening criteria.
- PEN-3221-8 and 10: located in former staging area adjacent to Building 3221; TCE previously detected in 3221-10 above screening criteria but not during 2005/06 sampling rounds.
- PEN-44-09: located downgradient of Building 3629; soil sample from boring 44SB02 near this building reported pesticides above migration to groundwater screening criteria; chloroform also detected in groundwater (0.8 J µg/L) above current RSL of 0.19 µg/L.
- PEN 44-11: TCE detected above screening criteria; chloroform also detected slightly above RSL.
- PEN-44-12, PEN-44-13: chloroform detected above current RSL.
- PEN-44-14: plume well with TCE exceeding screening criteria; chloroform also detected above RSL at 0.6 J µg/L.
- PEN-44-15: previously reported bis(2-ethylhexyl)phthalate, TCE above screening criteria (in-plume well); chloroform also detected slightly above RSL at 0.6 J µg/L.
- PEN-44-18: deep well within the TCE plume area; previously reported iron and manganese above screening criteria.
- PEN-44-19: deep well located near PEN-3221; previously reported iron, manganese, and bis(2-ethylhexyl)phthalate above screening criteria.
- PEN-44-21, PEN-44-24: plume wells with TCE exceeding screening criteria.

Also, in the recent SAP for this site, the Navy is proposing intermediate depth wells to be screened below the organic peat layer. Since this is a portion of the aquifer that has not been sampled previously, the full TCL/TAL is recommended for new intermediate and deep wells. Worksheet No. 18 lists the other Site 44 monitoring wells where the collected groundwater samples will be analyzed for only PCE and its daughter products as originally proposed in the DQO Meeting (Worksheet No. 9).

USEPA requested that three locations be selected for analysis of hexavalent chromium. The three locations consist of PEN-3221-01 and PEN-3221-05 where chromium (total) was detected at 24.1 and 17.4 µg/L and PEN-3221-09 at the washrack area where the highest detected concentration of TCE was detected.

Groundwater samples will be collected from select monitoring well locations (Worksheet No. 18) analyzed by an off-site laboratory for natural attenuation parameters to assess the favorability of geochemical conditions for reductive dechlorination.

After completion of the first monitoring event including all on-site monitoring wells, the data will be evaluated by the Partnering Team to optimize the number of shallow monitoring wells and specific parameters to be sampled at each well during subsequent monitoring events and to determine the locations of four new well clusters to further characterize the vertical extent of contamination. The hydraulic upgradient and downgradient monitoring well cluster locations will each include a shallow, intermediate, and deep well. The two in-plume monitoring well cluster locations will include intermediate and deep wells that are expected to be co-located with existing shallow monitoring wells. Multi-level monitoring wells are not considered to be an option for the well clusters because multi-level wells do not allow the capability to accurately determine groundwater elevations at the various screen intervals nor the related monitoring of water levels required for “low flow, low stress” groundwater sampling methods. Therefore, the locations of the proposed monitoring wells will not be determined until after the first sampling event.

Soil borings at new monitoring well cluster locations will be initiated with a stainless steel hand auger from the land surface to 4 feet bls to confirm utilities are not present. A Rotosonic drill rig will then be used to advance exploratory soil borings to the blue marine clay confining layer (approximate depth 75 feet bls) using 20-foot long continuous soil cores to confirm the lithology and to screen soil samples for volatile organic compounds. The soil cores will be sliced and screened their entire length using a FID/PID OVA meter. Based on the FID/PID measurements and visual inspection of the soil cores, the FOL will select soil samples representing zones of potentially higher contaminant levels for additional screening by the AQR Color-Tec® method.

The AQR Color-Tec® methodology utilizes a hand operated vacuum pump to purge volatile compounds from a sample through colorimetric gas detector tubes. The tubes are designed to produce a distinct color change when exposed to all cVOHs including saturated and unsaturated chlorinated alkenes and alkanes. This field screening method will only be used to determine the presence of cVOHs on a qualitative basis and not used to yield quantitative data for comparison against regulatory screening levels. The AQR Color-Tec® method will be conducted in accordance with USEPA’s SOPs for Analysis of Total Chlorinated Ethenes in Soil and Groundwater Using the Color Tec Screening Method and AQR Color-Tec® Method Procedures Manual.

The purpose of the field screening techniques, OVA and AQR Color-Tec®, will be used to determine monitoring well total depths and screen intervals for newly installed monitoring wells. This will be accomplished by field screening of soil samples from the low permeability layers and layers containing

peat or other organic material to assess the potential these layers may have sorbed higher concentrations of contaminants that could result in long-term back diffusion of PCE, TCE, cis-DCE, and VC.

An adjacent boring will then be advanced with the Rotosonic drill rig to collect groundwater samples using a Hydro-Punch® sampler from 5-foot intervals measured from the water table to the blue marine clay confining layer. The Hydro-Punch® sampler will be advanced ahead of the boring to allow the collection of groundwater samples using a small diameter bailer. Any water in the sampler will be purged prior to advancing to the next depth interval and any equipment used to extract the sample (i.e., tubing/pump or bailer) will be decontaminated between samples, unless dedicated equipment is used. The Hydro-Punch® sampler will be decontaminated in accordance with recommendations contained in USEPA's guidance document entitled Groundwater Sampling and Monitoring with Direct Push Technologies, Office of Solid Waste and Emergency Response, Washington, DC 20460, (OSWER No. 9200.1-51 EPA 540/R-04/005, August, 2005). This guidance states: "Multi-level samplers, most of which are exposed-screen samplers, are DPT equipment capable of collecting groundwater samples at multiple intervals as the sampling tool is advanced, without having to withdraw the tool for sample collection or decontamination." Furthermore, the document states: "As with all groundwater sampling equipment, DPT equipment should be decontaminated before sampling at a new location to avoid cross contamination." Therefore, the Hydro-Punch® sampler will be decontaminated between each boring in accordance with this USEPA guidance.

Groundwater samples from each of the 5-foot intervals will be screened using the AQR Color-Tec® method. The AQR Color-Tec® groundwater screening results will be evaluated in combination with the lithology and the OVA and AQR Color-Tec® soil screening results to determine appropriate depths for shallow, intermediate, and deep monitoring well screen intervals. In the event that AQR Color-Tec® groundwater screening results and the OVA and AQR Color-Tec® soil screening results are inconclusive or below the detection limits using the AQR Color-Tec® method, the FOL will select screen interval depths for the intermediate and deep wells based on inspection of the soil cores and identification of the more transmissive lithologic zones, which are expected to be within the respective intermediate and deep sand layers shown in the CSM (Figure 10-6), i.e., within the "Sand, Very Fine to Fine Grained" layer located directly below the "Organic Peat Layer", and within the "Sand" layer that overlies the "Clayey Sand" layer.

Shallow, intermediate, and deep monitoring wells will be located at each hydraulic upgradient and downgradient monitoring well cluster. Intermediate and deep monitoring wells will be collocated with two existing shallow monitoring wells within the TCE plume. The results of the first monitoring event will be

used to optimize the monitoring well network and parameters for the second and third monitoring events, which will include the new monitoring wells.

In addition, natural attenuation parameters will be collected at only select wells during the first sampling event as indicated in Worksheet No. 18 to establish the footprint of redox conditions along the centerline and edges of the plume, to assess the favorability of redox conditions along and downgradient of the plume for complete sequential reductive dechlorination or other biological or abiotic degradation. During the first sampling event, natural attenuation parameters will be sampled at all existing centerline plume wells where redox conditions may be expected to change with distance along the plume. In addition, representative wells have been selected for sampling of natural attenuation parameters upgradient, side gradient, and downgradient of the plume to provide sufficient information to determine the redox conditions in those areas that may be unaffected by plume COCs. As part of optimizing the monitoring plan for subsequent sampling events, the Partnering Team will determine the location of wells to be sampled in future events for natural attenuation parameters, as well as COCs, based on their evaluation of results from the first sampling event.

Based on evaluation of results from the first two monitoring events, the Partnering Team will further optimize the monitoring plan and will decide if the use of any MBTs is necessary to provide sufficient lines of evidence in support of MNA and achieve project goals. Examples of molecular biological tools (MBTs) to be considered include:

- qPCR: Groundwater samples collected from select wells along the plume flow path will be analyzed for Dehalococcoides and reductase genes to assess the presence of microbial populations that are capable of complete reductive dechlorination of PCE and TCE to ethene.

- CSIA: Stable carbon isotope analysis of TCE and cis-1,2 DCE will be performed for groundwater samples collected from select wells along the plume flow path to confirm degradation of TCE and cis-1,2 DCE is occurring.

- SIP – ^{13}C-labeled TCE and/or cis-DCE will be added to in-situ biotrap samplers and exposed to subsurface aquifer conditions for 2 to 3 months to evaluate the fate of chlorinated ethenes. SIP will allow labeled contaminants to be tracked in situ and probed in microbial biomarkers, including phospholipid fatty acids (PLFA), carbon dioxide, and possibly DNA. Detection of ^{13}C in biomarkers will provide evidence of biodegradation.

SAP Worksheet No. 18 -- Sampling Locations and Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Soil Sample ID	Purpose	Event 1
PEN-44-SS01-01	supplement existing TCL/TAL results	USEPA CLP TCL/TAL, pH, ORP & Cr^6
PEN-44-SS01-TBD	supplement existing TCL/TAL results	USEPA CLP TCL/TAL
PEN-44-SS02-01	supplement existing TCL/TAL results	USEPA CLP TCL/TAL, pH, ORP & Cr^6
PEN-44-SS02-TBD	supplement existing TCL/TAL results	USEPA CLP TCL/TAL
PEN-44-SS03-01	supplement existing TCL/TAL results	USEPA CLP TCL/TAL, pH, ORP & Cr^6
PEN-44-SS03-TBD	supplement existing TCL/TAL results	USEPA CLP TCL/TAL
Monitoring Well ID	**Purpose**	**Event 1**
PEN-44-09	Upgradient Well	USEPA CLP TCL/TAL; pH, ORP & NA Parameters
PEN-44-10	Cross-Gradient Well	PCE, TCE, cis-DCE, VC; NA Parameters
PEN-44-11	In-Plume Well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-12	Cross-Gradient Well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-13	Cross-Gradient Well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-14	In-Plume Well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-15	In-Plume Well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-16	Cross-Gradient Well	PCE, TCE, cis-DCE, VC
PEN-44-17	Cross-Gradient Well	PCE, TCE, cis-DCE, VC
PEN-44-18	Deep well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-19	Deep well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-20	Cross-Gradient Well	PCE, TCE, cis-DCE, VC
PEN-44-21	In-Plume Well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-22	Cross-Gradient Well	PCE, TCE, cis-DCE, VC; NA Parameters

Monitoring Well ID	Purpose	Event 1
PEN-44-23	Cross-Gradient Well	PCE, TCE, cis-DCE, VC; NA Parameters
PEN-44-24	Plume-Edge Well	USEPA CLP TCL/TAL; NA Parameters
PEN-44-25	Downgradient Well	PCE, TCE, cis-DCE, VC; NA Parameters
PEN-44-26	Cross-Gradient Well	PCE, TCE, cis-DCE, VC
PEN-3221-01	Upgradient Well/Former UST Location	PCE, TCE, cis-DCE, VC; NA Parameters & Cr^6
PEN-3221-02	Upgradient Well	USEPA CLP TCL/TAL pH, ORP
PEN-3221-03	Upgradient Well/Former UST Location	USEPA CLP TCL/TAL; pH, ORP; & NA Parameters
PEN-3221-04	Upgradient Well	USEPA CLP TCL/TAL
PEN-3221-05	Upgradient Well	PCE, TCE, cis-DCE, VC & Cr^6
PEN-3221-06	Upgradient Well	USEPA CLP TCL/TAL
PEN-3221-07	Upgradient Well	PCE, TCE, cis-DCE, VC; NA Parameters
PEN-3221-08	Upgradient Well	USEPA CLP TCL/TAL
PEN-3221-09	In-Plume Well	USEPA CLP TCL/TAL; NA Parameters & Cr^6
PEN-3221-10	Cross-Gradient Well	USEPA CLP TCL/TAL; NA Parameters
New Well Location #1 Shallow Well	Upgradient Shallow Well	Not Yet Installed
New Well Location #1 Intermediate Well	Upgradient Intermediate Well	Not Yet Installed
New Well Location #1 Deep Well	Upgradient Deep Well	Not Yet Installed
New Well Location #2 Intermediate Well	In-Plume Intermediate Well (Co-located with existing shallow well)	Not Yet Installed
New Well Location #2 Deep Well	In-Plume Deep Well (Co-located with existing shallow well)	Not Yet Installed
New Well Location #3 Intermediate Well	In-Plume Intermediate Well (Co-located with existing shallow well)	Not Yet Installed

New Well Location #3 Deep Well	In-Plume Deep Well (Co-located with existing shallow well)	Not Yet Installed
New Well Location #4 Shallow Well	Downgradient Shallow Well	Not Yet Installed
New Well Location #4 Intermediate Well	Downgradient Intermediate Well	Not Yet Installed
New Well Location #4 Deep Well	Downgradient Deep Well	Not Yet Installed

Notes:
PCE = tetrachloroethene
TCE = trichloroethene
cis-DCE = cis, 1,2-dichloroethene
VC = vinyl chloride
ORP = Oxidation Reduction Potential
$Cr^{6=}$ hexavalent chromium
USEPA CLP TCL & TAL = Analyte list provided in Worksheet 15
NA parameters = iron & manganese (total & dissolved); dissolved gases (methane, ethane, ethene, nitrogen, hydrogen & carbon dioxide); anions (chloride, nitrate, nitrite & sulfate); alkalinity, COD, BOD
qPCR[1] = Quantitative Polymerase Chain Reaction (qPCR) for Dehalococcoides and functional reductase genes
CSIA[1] = Compound Specific Isotope Analysis
SIP[1] = Stable Isotope Probing

(1) Molecular Biological Tools (MBTs), including qPCR, CSIA, and SIP: The decision to use any of these advanced diagnostic tools during the third sampling event will be made by the NAS Pensacola Partnering Team based on a review of previous monitoring results and if necessary to provide sufficient lines of evidence in support of MNA and achieve project goals.

SAP Worksheet No. 19 -- Analytical SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	**Analytical Group**	**Analytical and Preparation Method / SOP Reference**[1]	**Containers** (number, size, and type)	**Sample Volume** (units)	**Preservation Requirements** (chemical, temperature, light protected)	**Maximum Holding Time** (preparation/ analysis)
Groundwater and Aqueous Field QC Samples	TCL VOCs and cVOCs (PCE, TCE, cis-1,2-DCE, and VC)	SW-846 5030/8260B, Empirical SOP-202	Three – 40 milliliter (mL) glass vials	5 mL	Hydrochloric acid (HCl) to pH<2; Cool to < 6 °C; no headspace	14 days to analysis
	TCL SVOCs (including low level PAHs)	SW-846 3510C/8270D-Low, Empirical SOP-201/300	Two 1-liter (L) glass amber bottles	1,000 mL	Cool to 0 to 6 °C	7 days until extraction, 40 days to analysis
	TCL Pesticides and PCBs	SW-846 3510C/8081B/8082A, Empirical SOP-211/302	Two 1-L glass amber bottles	1,000 mL	Cool to 0 to 6 °C	7 days until extraction, 40 days to analysis
	TAL Metals (including mercury)	SW-846 3005A/ 6010C, SW-846 7470A, Empirical SOP-100/103/105	One 500-mL plastic bottle	50 mL	Nitric acid (HNO_3) to pH <2; Cool to 0 to 6 °C	180 days to analysis except mercury which is 28 days to analysis
	Hexavalent Chromium	EPA 218.6, CAS SOP GEN-7199	250mL HDPE	10 mL	$NH_4OH/(NH_4)_2SO_4$ sol'n PH 9.3-9.7 cool to 0 - 6° C	28 days to analysis
	ORP reported as Eh	ASTM D1498, CAS SOP GEN-REDOX	250mL glass no headspace	40 mL	Cool to 0 to 6 °C	ASAP
	pH	SW-846 9040, CAS SOP GEN 9040B	60 mL HDPE	25 mL	Cool to 0 to 6 °C	ASAP
	Dissolved Iron and Manganese	SW-846 3010A/6010C, Empirical SOP-100/105	One – 500 mL plastic bottle	50 mL	Nitric acid (HNO_3) to pH <2; Cool to < 6 °C	180 days to analysis
	Dissolved Gases (Methane, Ethane, Ethene, Nitrogen, and Carbon Dioxide)	RSK SOP 175, Microseeps SOP SM9/AM20 GAX	One –20 mL glass vial with stopper septa	20 mL	Benzalkonium Chloride; Cool to < 6 °C	14 days to analysis

Matrix	**Analytical Group**	**Analytical and Preparation Method / SOP Reference**[1]	**Containers** (number, size, and type)	**Sample Volume** (units)	**Preservation Requirements** (chemical, temperature, light protected)	**Maximum Holding Time** (preparation/ analysis)
Groundwater and Aqueous Field QC Samples	Dissolved Gases (Hydrogen)	RSK SOP 175, Microseeps SOP PM01/AM20 GAX	Two - 40 mL amber glass vials with dark grey septa	40 mL	Cool to < 6 °C	14 days to analysis
	Anions (nitrate, nitrite, chloride, and sulfate)	EPA 300.0, Empirical SOP-145	One - 500 mL plastic bottle	5 mL for each analyte	Cool to < 6 °C	Nitrate/Nitrite - 48 hours to analysis; Chloride/ Sulfate - 28 days to analysis
	BOD	Standard Methods (SM) 5210B, Empirical SOP-163	One –500 mL plastic bottle	250mL	Cool to < 6 °C	48 hours to analysis
	COD	EPA 410.4, Empirical SOP-169	One –500 mL plastic bottle	250mL	Sulfuric Acid (H_2SO_4) to pH <2; Cool to < 6 °C	28 days to analysis
	Alkalinity	SM 2320B, Empirical SOP-154	One –500 mL plastic bottle	25 mL	Cool to < 6 °C	14 days to analysis
	CSIA[2]	Laboratory Proprietary Method[3], Microseeps SOP AM24	9- 40 mL glass vials	5mL	HCl to pH<2;Cool to < 6 °C	180 days to analysis
	qPCR[2]	Laboratory Proprietary Method[3], MI SOP DNA-qPCR, MI SOP DNA Ext	One – 1 L plastic	1 L	Cool to < 6 °C	Extract within 28 hours and freeze at -20°C until analysis
Soil	TCL VOCs	SW-846 5035/8260B, Empirical SOP-202/225	Three 5-gram (g) Encore samplers or terracores	5 g	Sodium bisulfate in water, cool to < 6 °C; methanol, freeze to < -10°C	48 hours from sampling to preparation, 14 days to analysis
	TCL SVOCs (including low level PAHs)	SW-846 3546/ 8270D-Low, Empirical SOP-201/343	One 4-ounce (oz) glass jar with a Teflon-lined lid	15 g	Cool to 0 to 6 °C	14 days until extraction, 40 days to analysis
	TCL Pesticides/PCBs	SW-846 3546 /8081B/ 8082A, Empirical SOP-211/343	One 4-oz glass jar with a Teflon-lined lid	15 g	Cool to 0 to 6 °C	14 days until extraction, 40 days to analysis

Matrix	**Analytical Group**	**Analytical and Preparation Method / SOP Reference**[1]	**Containers** (number, size, and type)	**Sample Volume** (units)	**Preservation Requirements** (chemical, temperature, light protected)	**Maximum Holding Time** (preparation/ analysis)
Soil	TAL Metals (including mercury)	SW-846 3050B/ 6010C, SW-846 7471A Empirical SOP-100/104/105	One 4-oz glass jar with a Teflon-lined lid	1 to 2 grams	Cool to 0 to 6 °C	180 days to analysis except mercury which is 28 days to analysis
	Hexavalent Chromium	SW-846 7199 / CAS SOP GEN-7199, CAS SOPGEN-3060A	1-4 oz wide mouth	2.5 g	cool to 0 - 6° C	30 days until digestion; 7 days until pH adjustment and analysis
	ORP reported as Eh	ASTM D1498 CAS SOP GEN-REDOX	One 4- oz glass jar no headspace	20 g	Cool to 0 to 6 °C	ASAP
	pH	SW-846 9040/ CAS SOP GEN 9045C	One 4- oz glass jar	20 g	Cool to 0 to 6 °C	ASAP

Notes:

1 Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet No. 10).

2 Advanced diagnostic tools, including qPCR, CSIA, and SIP will be collected only during the third sampling event if, based on their review of the first two sampling events, the NAS Pensacola Partnering Team decides such additional lines of evidence are necessary to support the efficacy of MNA. SIP analysis is an emerging scientific application that is currently only available through academia and will be added to the Work Plan at a later date via FTMR or addendum if it is deemed necessary by the Team. QC information is not provided in any of the following worksheets for these advances diagnostic tools.

3 SOPs for Laboratory Proprietary Methods can be provided upon request.

SAP Worksheet No. 20 -- Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs(1)	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	Total No. of Samples to Lab
Soil	TCL VOCs	6	1	1/1	0	1	1	9
	TCL SVOCs (including low level PAHs)	6	1	1/1	0	1		8
	TCL Pesticides and PCBs	6	1	1/1	0	1		8
	TAL Metals (including mercury)	6	1	1/1	0	1		8
	Hexavalent Chromium	3	1	1/1	0	0		4
	pH and ORP	3	1	1/1	0	0		4
Groundwater	cVOCs (PCE, TCE, cis-1,2-DCE, and VC)	14	1	1/1	0	1	1	17
	Dissolved Iron and Manganese	19	1	1/1	0	0	0	20
	Dissolved Gases (Methane, Ethane, Ethene, Nitrogen, and Carbon Dioxide)	19	1	0	0	0	0	20
	Dissolved Gases (Hydrogen)	19	1	0	0	0	0	20
	Anions (nitrate, nitrite, chloride, and sulfate)	19	1	0	0	0	0	20
	BOD	19	1	0	0	0	0	20

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs(1)	No. of Field Blanks	No. of Equip. Blanks	No. of	Matrix
Groundwater	COD	19	1	0	0	0	0	20
	Alkalinity	19	1	0	0	0	0	20
	CSIA	TBD	0	0	0	0	0	TBD
	qPCR	TBD	0	0	0	0	0	TBD
	TCL VOCs	14	1	1/1	0	1	1	17
	TCL SVOCs	14	1	1/1	0	1	0	16
	TCL Pesticides and PCBs	14	1	1/1	0	1	0	16
	TAL Metals (including mercury)	14	1	1/1	0	1	0	16
	Hexavalent Chromium	3	1	1/1	0	0		4
	pH and ORP	3	1	1/1/	0	0		4

1 Although matrix spike/matrix spike duplicates (MS/MSDs) are not typically considered field QC samples, they are included here because location determination is often established in the field. The MS/MSDs are not included in the total number of samples sent to the laboratory. For total and dissolved metals, a duplicate sample will be collected in place of an MSD.

2 A separate sample will not be collected for this calculated value but the calculation will be performed on both the original and duplicate sample.

SAP Worksheet No. 21 -- Project Sampling SOP References Table

(UFP-QAPP Manual Section 3.1.2)

	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
CT-04	Sample Nomenclature (Revision 3, 1/2012)	Tetra Tech	N/A	N	SOPs contained in Appendix B.
CT-05	Database Records and Quality Assurance (Revision 3, 01/2012)	Tetra Tech	N/A	N	
GH-2.5	Groundwater Contour Maps and Flow Determinations (Revision 2, 1/2012)	Tetra Tech	N/A	N	
HS-1.0	Utility Location and Excavation Clearance, (Revision 3, 1/2012)	Tetra Tech	Sample Location Clearance Equipment	N	
SA-1.6	Natural Attenuation Parameter Collection (Revision 2, 1/2012)	Tetra Tech	CHEMetrics K-9810, -15, -20 CHEMetrics K-1910, -20, -25 and HACH DR/890	N	
SA-6.3	Field Documentation	Tetra Tech	N/A	N	
None	AQR Color-Tec® Method Procedures Manual Standard Operating Procedures for Analysis of Total Chlorinated Ethenes in Soil and Groundwater Using the Color Tec Screening Method http://www.epa.gov/superfund/programs/dfa/fldmeth.htm	AQR Color-Tec	Color-Tec® Equipment Kit	N	
SESDPROC-005-R1	Sample and Evidence Management (Revision 1)	USEPA	N/A	N	
SESDPROC-010-R4	Field Documentation (logbooks) (Revision 4)	USEPA	Field Logbook, Field Sample Forms, Boring Logs	N	
SESDPROC-011-R3	Field Sampling Quality Control (Revision 3)	USEPA	N/A	N	
SESDPROC-012-R2	Field Sampling and Measurement Procedures and Procedure Validation (Revision 2)	USEPA	N/A	N	

	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SESDPROC-100-R2	Field pH Measurement (Hydrogen Ion Activity) (Revision 2)	USEPA	pH Meter	N	
SESDGUID-101-R0	Monitoring Well Design and Installation (Revision 0)	USEPA	Health and Safety equipment, well drilling and installation equipment, hydrogeologic equipment, drive point tools	N	SOPs contained in Appendix B.
SESDPOC—101-R2	Field Specific Conductance Measurement (Revision 2)	USEPA	Specific Conductance Meter	N	
SESDPROC-102-R3	Field Temperature Measurement (Revision 2)	USEPA	Thermistor, Thermometer, or Temperature Sensor	N	
SESDPROC-103-R2	Field Turbidity Measurement (Revision 2)	USEPA	Turbidity Sensor	N	
SESDPROC-105-R1	Groundwater Level and Well Depth Measurement (Revision 1)	USEPA	Electronic Water Level Indicator	N	
SESDPROC-106-R2	Field Measurement of Dissolved Oxygen (DO) (Revision 2)	USEPA	DO Sensor	N	
SESDPROC-108-R3	Equipment Inventory and Management	USEPA	N/A	N	
SESDPROC-110-R3	Global Positioning System (GPS) (Revision 3)	USEPA	GPS Equipment	N	
SESDPROC-111-R2	In Situ Water Quality Monitoring (Revision 2)	USEPA	Multi-parameter Water Quality Meter	N	
SESDPROC-113-R0	Field Measurement of Oxidation-Reduction Potential (ORP) (Revision 0)	USEPA	ORP Meter	N	
SESDPROC-202-R2	Management of Investigation Derived Waste (revision 2)	USEPA	N/A	N	

	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SESDPROC-205-R1	Field Equipment Cleaning and Decontamination (Revision 1)	USEPA	Decontamination Equipment (scrub brushes, phosphate-free detergent, DI water)	N	
SESDPROC-209-R2	Packing, Marking, Labeling and Shipping of Environmental Samples (Revision 2)	USEPA	Sample Bottle Ware, Packaging Material, Shipping Materials	N	SOPs contained in Appendix B.
SESDPROC-300-R1	Soil Sampling (Revision 1)	USEPA	Various Soil Sampling Equipment	N	
SESDPROC-301-R1	Groundwater Sampling (Revision 1)	USEPA	Peristaltic Pump	N	

Notes:

U.S. Environmental Protection Agency Field SOPS were obtained at the following website: http://www.epa.gov/region4/sesd/fbqstp/#QualitySystem

N/A – Not Applicable

SAP Worksheet No. 22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity[1]	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[2]	Comments
GPS	Positioning	Beginning and end of each day used	Accuracy: sub-meter horizontal dilution of precision <3, number of satellites at least six.	Wait for better signal, replace unit, or choose alternate location technique	Tetra Tech FOL or designee	SESDPROC-110-R3	SOP located in Appendix B.
Multi-Parameter Water Quality Meter (YSI 600 Series or similar)	Visual Inspection Calibration/ Verification	Daily Beginning and end of day	Manufacturer's guidance.	Operator correction or replacement	Tetra Tech FOL or designee	SESDPROCs: 111-R2, 106-R2, 113-R0, 100-R2, or 101-R2	SOP located in Appendix B.
Photo-Ionization Detector and Flame Ionization detector	Visual Inspection Calibration/ Verification	Daily Beginning and end of day	Manufacturer's guidance	Operator correction or Replacement	Tetra Tech FOL or designee	Operation according to manufacturer's instructions	SOP located in Appendix B.
Turbidity Meter (LaMotte 2020 or similar)	Visual Inspection Calibration/ Verification	Daily Beginning and end of day	Manufacturer's guidance; calibrations must bracket expected values. Initial Calibration Verification (ICV) must be <10 nephelometric turbidity units (NTUs).	Operator correction or replacement	Tetra Tech FOL or designee	SESDPROC-103-R2	SOP located in Appendix B.

Field equipment will be inventoried, inspected and managed in accordance with procedures described in USEPA SOP SESDPROC-108-R3

1 Activities may include calibration, verification, testing, maintenance, and/or inspection.
2 From the Project Sampling SOP References table (Worksheet No. 21).

SAP Worksheet No. 23 -- Analytical SOP References Table

(UFP-QAPP Manual Section 3.2.1)

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM? (Y/N)	Modified for Project Work?[1] (Y/N)
Empirical SOP-100	Metals Digestion/ Preparation, Methods 3005A/ USEPA CLP ILMO 4.1 Aqueous, 3010A, 3030C, 3050B, USEPA CLP ILMO 4.1 (Soil/Sediment), 200.7, Standard Methods 3030C (Revision 21, 09/01/10)	Definitive	Soil, Groundwater and Aqueous Field QC Samples/ Metals Digestion	Preparation	Empirical	N	N
Empirical SOP-103	Mercury Analysis in Water by Manual Cold Vapor Technique, Methods USEPA SW846 7470A and 245.1, CLP-M 4.1 (REV20, 05/16/11)	Definitive	Groundwater and Aqueous QC samples/ Mercury	Flow Injection Mercury Analyzer	Empirical	N	N
Empirical SOP-104	Mercury Analysis in Soil/Sediment by Manual Cold Vapor Technique, Methods SW846 7471A, 7471B, 245.5, and CLP-ILM 4.1 (Revision 20, 05/16/11)	Definitive	Soil/Mercury	Flow Injection Mercury Analyzer	Empirical	N	N
Empirical SOP-105	Metals by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) Technique, SW-846 Methods 6010B, 6010C, USEPA Method 200.7, Standard Methods 19th Edition 2340B, USEPA CLP ILMO 4.1 (Revision 16, 04/11/10)	Definitive	Soil, Groundwater and Aqueous Field QC Samples/ Metals	Inductively Coupled Plasma (ICP) – Atomic Emission Spectroscopy (AES)	Empirical	N	N
Empirical SOP-145	Determination of Inorganic Anions in Water by Ion Chromatography using Dionex DX-500 Ion Chromatographs with Hydroxide Eluent and Dionex Column AS18, Method 300.0 Guidance (Revision 7, 03/25/10)	Screening	Groundwater/ Anions	Dionex Ion Chromatography (IC)	Empirical	N	N

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM? (Y/N)	Modified for Project Work?[1] (Y/N)
Empirical SOP-154	Total Alkalinity, Carbonate, Bicarbonate, USEPA Method 310.1, SM2320B (Revision 6, 09/07/10)	Screening	Groundwater/ Alkalinity	Buret/ pH meter	Empirical	N	N
Empirical SOP-163	Chemical Oxygen Demand (High & Low) USEPA Method 410.4 (Colorimetric, Manual) (Revision 6, 01/08/09)	Screening	Groundwater/ COD	Spectrophotometer	Empirical	N	N
Empirical SOP-169	Biochemical Oxygen Demand (BOD) & Carbonaceous Biochemical Oxygen Demand (CBOD), Standard Methods SM5210B and Method 405.1 (5 days at 20 degrees C) (Revision 8, 12/22/08)	Screening	Groundwater/ BOD	BOD (Dissolved Oxygen) Meter	Empirical	NA	N
Empirical SOP-201	Gas Chromatography Mass Spectrometry (GC/MS) semivolatiles and Low-Concentration PAHs using USEPA Method 625 and SW846 Method 8270C and 8270D, Including Appendix IX Compounds (Revision 21, 05/16/11)	Definitive	Soil, Groundwater, and aqueous QC samples/ SVOCs (including low level PAHs)	GC/MS	Empirical	N	N
Empirical SOP-202	GC/MS Volatiles using USEPA Method 624 and SW846 Method 8260B, Including Appendix IX Compounds (Revision 23, 09/09/10)	Definitive	Soil, Groundwater, and Aqueous Field QC Samples/ cVOCs and VOCs	Gas Chromatography/Mass Spectrometry (GC/MS)	Empirical	N	N
Empirical SOP-211	GC/ECD Organochlorine Pesticides/ PCBs using USEPA Method 608608.2 or SW846 Method 8081A/8082 or 8081B/8082A (Revision 24, 05/16/11)	Definitive	Soil, Groundwater, and aqueous QC samples/ Pesticides and PCBs	GC/ECD	Empirical	N	N

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM? (Y/N)	Modified for Project Work?[1] (Y/N)
Empirical SOP-225	GC/MS Volatile Non-Aqueous Matrix Extraction using SW-846 Method 5035 for 8260B Analysis (Revision 09, 09/07/10)	Definitive	Soil/VOCs Extraction	NA/ Extraction	Empirical	NA	N
Empirical SOP-300	GC/MS - Semivolatile BNA-Aqueous Matrix Extraction using SW-846 Method 3510C for 8270/625 Analysis (Revision 19, 11/17/10)	Definitive	Groundwater and Aqueous QC samples/ Low-level SVOC Extraction	NA/ Extraction	Empirical	NA	N
Empirical SOP-302	Pesticide/PCBs, Aqueous Matrix Extraction for USEPA 608/608.2 and SW846 Method 8081A/8082 Using SW846 Method 3510C (Revision 19, 01/12/11)	Definitive	Groundwater and Aqueous QC samples/ Pesticide and PCBs Extraction	NA/ Extraction	Empirical	NA	N
Empirical SOP-343	Base, Neutral, Acid (BNA), Pesticides/PCBs, and Total Petroleum Hydrocarbon (TPH) non-Aqueous Matrix (Microwave Extraction) using SW-846 3546 (Revision 02, 11/17/10)	Definitive	Soil / low level SVOCs/Pesticide and PCBs Extraction	NA/ Extraction	Empirical	NA	N
CAS SOP GEN-7199	Hexavalent Chromium by Ion Chromatography, Rev. 3, 1/13/11	Definiitve	Soil and Groundwater/ Hexavalent Chromium	IC	Columbia Analytical Services	NA	N
CAS SOP GEN-3060	Alkaline Digestion for Hexavalent Chromium in Soil, Rev. 2, 1/6/11	Definitive	Soil/ Hexavalent Chromium extraction	NA/ Extraction	Columbia Analytical Services	NA	N
CAS SOP GEN-9045C	Corrosivity pH by SW-846 9045C, (Revision 2, 1/10/11)	Definiitve	Soil / pH	pH meter	Columbia Analytical Services	NA	N
CAS SOP GEN-4500H+B	pH in water and Aqueous Wastes (Revision 4, 10/14/11)	Definiitve	Groundwater / pH	pH meter	Columbia Analytical Services	NA	N
CAS SOP GEN-REDOX	Redox Potential (Revision 4, 7/18/11)	Definitive	Soil and Groundwater/ ORP	Redox meter	Columbia Analytical Services	NA	N

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM? (Y/N)	Modified for Project Work?[1] (Y/N)
Proprietary Microseeps SOP- AM24	Measurement of Compound Specific Isotope Ratios with Gas Chromatography (Revision 1, 04/21/08)	Screening	Groundwater, and Aqueous Field QC Samples/ VOCs	Gas Chromatography/ Isotopic Ratio Mass spectrometer (GC/IRMS).	Microseeps	NA	N
Proprietary Microseeps SOP- AM20GAx	Analytical Method AM20GAx Standard Operating Procedure for the Analysis of Biodegradation Indicator Gases (Revision 11, 10/12/10)	Screening	Groundwater and Aqueous Field QC Samples/ Hydrogen Bubblestrip Vapor and Dissolved Gases	Gas Chromatography/ Flame Ionization Detector (GC/FID)	Microseeps	NA	N
Proprietary Microseeps SOP- SM9	Collection of Dissolved Gases from Water Using the "Bubblestrip" Sampling Technique at the Well Site (Revision 4, 05/01/09)	Screening	Groundwater and Aqueous Field QC Samples/ Hydrogen Bubblestrip Vapor	Sampling Procedure	Microseeps	NA	N
Proprietary Microseeps SOP-PM01	Preparation of Samples for the Analysis of Biodegradation Indicator Gases (Revision 6, 10/20/09)	Screening	Groundwater and Aqueous Field QC Samples/ Dissolved Gases	Preparation Procedure	Microseeps	NA	N
MI SOP-DNA EXT	Extraction of DNA from Environmental Samples (matrix-water, soil, biofilm, bio-Sep beads) (Revision 1, 01/05/06)	Screening	Groundwater/DNA Extraction	Incubator	Microbial Insights	NA	N
MI SOP-DNA qPCR	Quantitative Polymerase Chain Reaction (qPCR) (Revision 1, 01/05/06)	Screening	Groundwater/ qPCR	Applied Biosystems	Microbial Insights	NA	N

Laboratory Standard Operating Procedures were provided in the Draft Final UFP-SAP and will be provided electronically upon request.

SAP Worksheet No. 24 -- Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS VOCs	Bromofluoro-benzene (BFB) Tune	Prior to each Initial Calibration (ICAL) and at the beginning of each 12-hour period.	Must meet the ion abundance criteria required by the method (SW-846 8260B; Section 7.3.1; Table 4).	Retune and/or clean or replace source. No samples may be accepted without a valid tune.	Analyst/ Supervisor	Empirical SOP-202
	ICAL – a minimum of a 5-point calibration is prepared for all target analytes	Upon instrument receipt, for major instrument changes, or when continuing calibration verification (CCV) does not meet criteria.	The average response factor (RF) for System Performance Check Compound (SPCCs) must be ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. The percent relative standard deviation (%RSD) for RFs for calibration check compounds (CCCs) must be ≤ 30%; and %RSD for each target analyte must be ≤ 15%, or the linear regression correlation coefficient (r) must be ≥ 0.995; or the coefficient of determination (r^2) must be ≥ 0.99 (6 points are required for second order).	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	
	Retention Time (RT) Window Position Establishment	Once per ICAL for each analyte and surrogate.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA.	Analyst/ Supervisor	
	Evaluation of Relative Retention Times (RRTs)	With each sample.	RRT of each target analyte must be within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Analyst/ Supervisor	
	Initial Calibration Verification (ICV) – Second Source	Once after each ICAL, prior to beginning a sample run.	The percent recovery (%R) for all target analytes must be within 80-120% of true values.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS VOCs	CCV	Perform one per 12-hour analysis period after tune and before sample analysis.	The minimum RF for SPCCs must be ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. The percent difference or percent drift (%D) for all target analytes and surrogates must be ≤ 20%.	Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV.	Analyst/ Supervisor	Empirical SOP-202
IC Dionex Anions	ICAL – A minimum of a 3-point calibration is prepared and a linear range is established for all target analyses.	Perform after major instrument maintenance and upon failure of second consecutive CCV.	The %RSD must be < 15% over linear range, or r ≥0.995.	Correct the problem, then repeat ICAL.	Analyst / Supervisor	Empirical SOP-145
	ICV – Second Source	Once after each ICAL prior to sample analysis.	The %R must be within 90-110% of true value and RTs must be within appropriate windows.	Correct problem and verify ICV. If that fails, repeat ICAL.	Analyst / Supervisor	
	CCV	At the beginning and end of the sequence and after every 10 samples.	The %R must be within 90-110% of true value and all project analytes must be within established RT windows.	Correct problem and verify CCV. If that fails, repeat ICAL and reanalyze all samples since the last successful CCV.	Analyst / Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
DO Meter BOD	ICAL - Calibrate using instrument internal calibration.	Every time instrument is started, perform internal calibration.	Meets instrument specifications and complete internal calibration.	Check probe and try to recalibrate. Follow meter manual. Consult vendor.	Analyst, Supervisor	Empirical SOP-169
	ICV - Verify Calibration using Winkler titration.	Checked every month by the Winkler method.	The results between the DO meter and the Winkler titration should agree within ± 10%D.	Check probe and try to recalibrate. Follow meter manual. Consult vendor.	Analyst, Supervisor	
	CCV	Every 10 bottles read.	Must be within ± 0.10 of initial reading after meter is calibrated.	Check probe and try to recalibrate. Follow meter manual. Consult vendor.	Analyst, Supervisor	
Spectrophotometer COD	ICAL - High and low level calibration with 6 points each.	Every three months, or after a CCV fails.	r must be ≥ 0.997.	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst, Supervisor	Empirical SOP-163
	ICV – Second Source	After each ICAL prior to sample analysis.	The %R must be within 90-110% of true value.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst, Supervisor	
	CCV	At the beginning of each sequence and after every 10 samples, alternate high and low CCV (400 mg/L and 100 mg/L).	The %R must be within 90-110% of true value.	Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV.	Analyst, Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
pH Meter Alkalinity	Standardization	Daily prior to sample analysis.	Standardize using pH 7 and pH 4, adjust as needed, and reread. Must be within ± 0.05 pH units to proceed.	Restandardize.	Analyst, Supervisor	Empirical SOP-154
	Buffer check	Check every 3 hours.	Must be within ± 0.20 pH units.	Restandardize and rerun samples.	Analyst, Supervisor	
GC-FID Dissolved Gases	ICAL – a minimum of a 5-point calibration is prepared for all target analytes.	Perform after major instrument maintenance and upon failure of second consecutive CCV as needed.	r must be ≥ 0.995.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst, Supervisor	Microseeps SOP AM20GAx
	ICV – Second Source	Once after each ICAL prior to sample analysis.	The %R of all analytes must be within 80-120% of true value.	Correct problem and verify second source standard. Reanalyze ICAL.	Analyst, Supervisor	
	CCV	At the beginning and end of the sequence and after every 10 samples.	The %R of all analytes must be within 80-120% of true value.	Repeat ICAL and reanalyze all samples analyzed since the last successful CCV.	Analyst, Supervisor	
GC/MS SVOCs (including low level PAHs)	Breakdown Check (DDT only)	At the beginning of each 12-hour analytical sequence.	The degradation must be ≤ 20% for DDT to verify inertness of the injection port.	Correct the problem then repeat breakdown check. No samples shall be run until degradation is ≤20% for DDT.	Analyst/ Supervisor	Empirical SOP-201
	Tune Verification – DFTPP	Prior to each ICAL and at the beginning of each 12-hour analytical sequence.	Must meet the ion abundance criteria required by the method (SW-846 8270C Low Level Full Scan; Section 7.3.1; Table 3).	Retune and/or clean or replace source. No samples may be accepted without a valid tune.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS SVOCs (including low level PAHs)	ICAL – A minimum of a 5-point calibration is prepared for all target analytes	Upon instrument receipt, instrument change (new column, source cleaning, etc.), when CCV is out of criteria.	The average RF for SPCCs must be ≥ 0.050. The %RSD for RFs for CCCs must be ≤ 30%; and %RSD for each target analyte must be ≤ 15%, or r must be ≥ 0.995; or r^2 must be ≥ 0.99 (minimum of 6 points required for second order).	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	Empirical SOP-201
	ICV – Second Source	Perform after each ICAL, prior to beginning a sample run.	The %R of all target analytes must be within 80-120% of the true value. SPCC RFs must be ≥ 0.050; CCCs must be ≤ 20%D.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst/ Supervisor	
	RT Window Position Establishment	Once per ICAL for each analyte and surrogate.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA.	Analyst / Supervisor	
	Evaluation of RTs	With each sample.	RT of each target analyte must be within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Analyst / Supervisor	
	CCV	Analyze a standard at the beginning of each 12-hour shift after tune and before sample analysis.	SPCC RFs must be ≥ 0.050; all target analytes and surrogates must be ≤ 20%D.	If %D is high and sample result is non-detect (ND), qualify/narrate with project approval. If %D is low or project approval not received, reanalyze all samples since the last successful CCV.	Analyst/ Supervisor	
GC/ECD PCBs	ICAL - A minimum of a 5-point calibration of Aroclor 1660 (1016/1260 mixture) is prepared	Upon instrument receipt, major instrument change, when CCV does not meet criteria.	Option 1: %RSD must be ≤20% for Aroclor 1016/1260. If not met, Option 2: r must be ≥ 0.995; or Option 3: r^2 must be ≥ 0.99 for 6-point calibration. Mid-point calibration of other Aroclors – if an Aroclor is detected in a sample, a minimum of 5-point ICAL must be performed and meet the above criteria.	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	Empirical SOP-211

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/ECD PCBs	ICV – Second Source	Once after each ICAL prior to sample analysis.	The %R of all target analytes must be within 80-120% of true value.	Evaluate, repeat, if still failing, recalibrate.	Analyst/ Supervisor	Empirical SOP-211
	CCV	Analyze standard at the beginning and end of sequence and after every 10 samples.	The %D of all target analytes must be ≤20%.	If %D is high and sample result is ND, qualify/narrate with project approval. If %D is low or project approval not received, reanalyze all samples since the last successful CCV.	Analyst/ Supervisor	
GC/ECD Pesticides	Breakdown Check – Endrin/DDT	At the beginning of each 12 hour period, prior to analysis of samples.	The degradation must be ≤ 15% for both DDT and Endrin to verify the inertness of the injection port.	Correct the problem then repeat breakdown check. No samples shall be run until degradation is ≤15% for both DDT and Endrin.	Analyst/ Supervisor	Empirical SOP-211
	ICAL – A minimum of a 5-point calibration of individual pesticides, with a mid-point calibration of toxaphene and chlordane, is prepared for all target analytes	Upon instrument receipt, major instrument change, or when the CCV does not meet criteria, prior to sample analysis.	The %RSD for RFs for each target analyte must be ≤ 20%, or r must be ≥ 0.995, or r^2 must be ≥ 0.99 (minimum of 6 points required for second order).	Correct problem and repeat ICAL. If a single-point calibration for toxaphene or chlordane is used and toxaphene or chlordane is identified in analysis of a sample, a minimum of a 5-point ICAL of the identified compound with reanalysis of sample must be performed. No samples may be run until ICAL has passed.	Analyst/ Supervisor	Empirical SOP-211
	ICV – Second Source	Once after each ICAL prior to sample analysis.	The %R of all target analytes must be within 80-120% of true value.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst/ Supervisor	
	CCV	Analyze standard at the beginning and end of sequence and after every 10 samples.	The %D of all target analytes must be ≤20%.	If %D is high and sample result is ND, qualify/narrate with project approval. If %D is low or project approval not received, reanalyze all samples since the last successful CCV.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ICP-AES Metals (including dissolved iron and manganese)	ICAL - a 1-point calibration per manufacturer's guidelines is prepared for all target analytes	At the beginning of each day, or if the QC is out of criteria, prior to sample analysis.	None; only one high standard and a calibration blank must be analyzed. If more than one calibration standard is used, r must be ≥ 0.995.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-105
	ICV – Second Source	Following ICAL, prior to the analysis of samples.	The %R of all target analytes must be within 90-110% of true value.	Investigate reasons for failure, reanalyze once. If still unacceptable, correct problem and repeat ICAL.	Analyst/ Supervisor	
	CCV	At the beginning and end of the sequence and after every 10 samples.	The %R must be within 90-110% of true value.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze all affected samples.	Analyst/ Supervisor	
	Initial Calibration Blank (ICB)	Before beginning a sample sequence.	No target analytes detected > LOD.	Correct the problem, then re-prepare and reanalyze.	Analyst / Supervisor	
	CCB	After the initial CCV, after every 10 samples, and at the end of the sequence.	No target analytes detected > LOD.	Correct the problem, then re-prepare and reanalyze calibration blank and all affected samples.	Analyst / Supervisor	
	Low-Level Check Standard (if using 1-point ICAL) – not for mercury	Daily after 1-point ICAL and before samples.	The %R must be within 80-120% of true value.	Investigate and perform necessary equipment maintenance. Recalibrate and reanalyze all affected samples.	Analyst / Supervisor	
	Interference Check Standards (ICS – ICS A and ICS B) – not for mercury	At the beginning of an analytical run.	ICS A recoveries must be within the absolute value of the LOD; and ICS B recoveries must be within 80-120 %R of true value.	Terminate analysis; locate and correct problem; reanalyze ICS.	Analyst / Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Flow Injection Analyzer Mercury	ICAL – A minimum of a 5-point calibration curve is prepared	Perform daily prior to sample analysis.	The RSD for RFs must be ≤ 20%, or r must be ≥ 0.995.	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	Empirical SOP-103/104
	ICV – Second Source	Following ICAL, prior to the analysis of samples.	The %R must be within 90-110% of true value.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst/ Supervisor	
	Calibration Blank	One is performed at the beginning of analytical sequence, after every 10 samples, and at the end of the sequence.	The target analyte concentration must be < LOD.	Re-prepare and analyze all associated samples.	Analyst/ Supervisor	
	CCV	Perform after every 10 samples and at the end of the analytical sequence.	The %R must be within 80-120% of true value.	Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV.	Analyst/ Supervisor	
	CCV (undistilled)	CCV (undistilled) at the beginning and end of each run sequence and after every 10 samples.	The %R must be within 90-100% of true value.	If the CCV (undistilled) fails high, report samples that are <LOQ. Recalibrate and/or reanalyze samples back to last acceptable CCV.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
IC/UVVIS	ICAL	Prior to sample analysis	CC > 0.999	Correct problem then repeat ICAL	Analyst / Supervisor	CAS SOP GEN-7199
	ICV	After each ICAL	90-110% Recovery	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst / Supervisor	
	CCV	At the beginning of the analytical sequence; after each 10 field samples; at the end of the analytical sequence	90-110% Recovery	Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last acceptable CCV.	Analyst / Supervisor	
pH Meter	ICAL	Calibrate daily before use with two to three buffers	0.05 pH units.	Recalibrate and/or perform necessary equipment maintenance.	Analyst/Supervisor	CAS SOP GEN-9045C and CAAS SOP Gen-4500H+B
	CCV	Every 20 samples and at the end of each analytical sequence.	0.05 pH units of the true value	Reanalyze the CCV using a new aliquot. If the result is still not compliant, then recalibrate the meter and re-analyze all of the samples after the last compliant CCV	Analyst/Supervisor	
ORP Meter	ICAL	Calibrate daily before use, using 2 reference solutions.	Results must be within 15% of the true value.	Recalibrate and/or perform necessary equipment maintenance.	Analyst/Supervisor	CAS SOP GEN-ORP
	CCV	Every 20 samples and at the end of each analytical sequence.	Results must be within 15% of the true value.	If the value of the reference solution exceeds 15% of the true value, correct the problem and reanalyze the affected samples, (bound by the out of control reference).	Analyst/Supervisor	

SAP Worksheet No. 25 -- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.2.3)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
GC/MS	Check pressure and gas supply daily. Bake out trap and column, change septa as needed, cut column as needed, change trap as needed. Other maintenance specified in Equipment Maintenance SOP.	VOCs	Ion source, injector liner, column, column flow, purge lines, purge flow, trap.	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-202
GC/MS	Check pressure and gas supply daily. Change septa as needed, change liner as needed, cut column as needed. Other maintenance specified in Equipment Maintenance SOP.	SVOCs (including low level PAHs)	Ion source, injector liner, column, column flow.	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-201
GC/ECD	Check pressure and gas supply daily. Bake out column, change septa and/or liner as needed, replace or cut column as needed. Other maintenance specified in Equipment Maintenance SOP.	Pesticides and PCBs	Injector liner, septa, column, column flow.	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	If % D > 20% and samples are < LOD, narrate. If %D > 20% only on one column, narrate. If % D > 20% for closing CCV, and is likely due to matrix interference, narrate. Otherwise, reanalyze all samples since the last acceptable CCV.	Analyst/ Supervisor	Empirical SOP-211
Flow Injection Analyzer	Replace peristaltic pump tubing, replace mercury lamp, replace drying tube, clean optical cell and/or clean liquid/gas separator as needed. Other maintenance specified in Equipment Maintenance SOP.	Mercury	Inspect the tubing, filter, and the optical cell	Prior to ICAL and as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-103/104
ICP-AES	Clean the torch assembly and the spray chamber when they become discolored or when degradation in data quality is observed. Clean the nebulizer, and check the argon supply. Replace the peristaltic pump	Metals (except mercury)	Inspect the torch, nebulizer chamber, pump, and tubing	Prior to ICAL and as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-105

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
	tubing as needed.							
IC/UVVIS	Change column bed supports	Hexavalent Chromium	Change column bed supports	monthly or as needed	must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service	Analyst/ Supervisor	CAS SOP GEN-7199
	Clean column		Clean column	monthly or as needed	must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service		
	Change column		Change column	Every 6 months or as needed	must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service		
	Change tubing		Change tubing	Annually or as needed	must meet initial and/or continuing calibration criteria	Repeat maintenance activity or remove from service		
pH meter	NA	pH	Visual inspection of probe.	Each use.	NA.	Remove from service.	Analyst, Supervisor	CAS SOP GEN-9045C and CAAS SOP Gen-4500H+B
pH meter	NA	ORP	Visual inspection of probe.	Each use.	NA.	Remove from service.	Analyst, Supervisor	CAS SOP GEN-REDOX
IC Dionex	NA	Anions	NA	NA	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst, Supervisor	Empirical SOP-145

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
GC/FID	Replace Septa, Check gases, Clean FID, replace TCD filaments, Change activated carbon, Bake out column.	Dissolved Gases	Visual inspection of septa, FID, Filaments	Prior to ICAL and as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst	Microseeps SOP-AM20GAx
DO Meter	Change probe membrane once a month.	BOD	Visual inspection of probe.	Each use.	NA.	Remove from service.	Analyst, Supervisor	Empirical SOP-169
Spectrophoto meter	Change lamp as needed.	COD	Visual inspection of lamp.	Each use.	Must meet ICAL and CCV.	Try to recalibrate or contact vendor. Remove from service if not able to fix.	Analyst, Supervisor	Empirical SOP-163
pH Meter	NA	Alkalinity	Visual inspection of probe.	Each use.	NA.	Remove from service.	Analyst, Supervisor	Empirical SOP-154

SAP Worksheet No. 26 -- Sample Handling System

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FOL / Tetra Tech
Sample Packaging (Personnel/Organization): FOL / Tetra Tech
Coordination of Shipment (Personnel/Organization): FOL / Tetra Tech
Type of Shipment/Carrier: Overnight courier service (Federal Express)
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Custodians/ Empirical, Microseeps, Columbia Analytical Services, and Microbial Insights
Sample Custody and Storage (Personnel/Organization): Sample Custodians/ Empirical, Microseeps, Columbia Analytical Services, and Microbial Insights
Sample Preparation (Personnel/Organization): Extraction Laboratory, Metals Preparation Laboratory/Empirical and Columbia Analytical Services; Microseeps and Microbial Insights
Sample Determinative Analysis (Personnel/Organization): GC Laboratory, GC/MS Laboratory, Metals Laboratory / Empirical and Columbia Analytical Services; Microseeps and Microbial Insights
SAMPLE ARCHIVING
Field Sample Storage (Number of days from sample collection): 60 days from receipt
Sample Extract/Digestate Storage (number of days from extraction/digestion): 3 months from sample digestion/extraction
Biological Sample Storage (Number of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Sample Custodians/ Empirical, Microseeps, Columbia Analytical Services , and Microbial Insights

SAP Worksheet No. 27 – Sample Custody Requirements Table

(UFP-QAPP Manual Section 3.3.3)

27.1 FIELD SAMPLE CUSTODY PROCEDURES

Sample Chain-of-Custody forms will be completed per Tetra Tech SOP SA-6.3. An example is included in Appendix B.

The following sections outline the procedures that will be used to document project activities and sample collection, handling tracking, and custody procedures during the investigation.

27.2 SAMPLE NOMENCLATURE

Worksheet No. 18 presents the sample nomenclature for the field and lists QA/QC samples to be collected.

27.3 SAMPLE COLLECTION AND DOCUMENTATION

Documentation of field observations will be recorded in a field logbook and/or on field log sheets including sample collection logs and boring logs. Bound, water-resistant field logbooks will be used for this project. Logbook pages will be numbered sequentially, and observations will be recorded with indelible ink.

Field sample log sheets will be used to document sample collection details. Other observations and activities will be recorded in the field logbook. Daily instrument calibration will be recorded in instrument calibration logs. Example field forms are included in Appendix B.

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

- Site name and location
- Date and time
- Personnel and their affiliations
- Weather conditions
- Activities associated with sampling
- Subcontractor activity summary
- Site observations including site entry and exit times
- Site sketches monitoring well layout, if different than sampling plan figures

- Visitor names, affiliations, and arrival and departure times
- Health and safety issues including personal protection equipment

27.4 SAMPLE PACKAGING AND SHIPPING

Samples will be prepared for shipping using the following guidelines:

- Place properly identified sample container, with lid securely fastened, in a plastic bag (i.e., Ziploc-type bag), and seal bag.
- Place sample in a sturdy cooler that has been lined with a large plastic bag (i.e., garbage bag). Drain plugs on coolers should be taped shut.
- Place a temperature check indicator provided by the laboratory in each cooler to be shipped.
- Pack with sufficient cushioning materials, such as bubble wrap, to minimize the possibility of the containers breaking.
- If cooling is required, pack sample containers in ice to adequately cool sample to 0 to 6 °C.
- Seal large liner bag by taping or knotting open end.
- Tape the original top, signed copy of the chain-of-custody form shall be placed in a large Ziploc-type bag inside the lid of the shipping cooler. If multiple coolers are sent but samples are included on one chain-of-custody form, the chain-of-custody form should then indicate how many coolers are included with the shipment.
- Close and seal the outside of shipping cooler using strapping tape. Place custody seals across the lid and body of cooler and under strapping tape to prevent tampering while in transit. No Department of Transportation marking is required.

27.5 SAMPLE HANDLING AND TRACKING SYSTEM

Sample handling is described in Worksheet No. 26. Samples must be delivered to the laboratory via a public courier (e.g., Federal Express). Samples must be sent to the laboratory within 24 hours of being collected. Under no circumstances should sample holding times be exceeded.

27.6 SAMPLE CUSTODY

To ensure the integrity of a sample from collection through analysis, it is necessary to have an accurate written record that traces the possession and handling of the sample. This documentation is referred to as the chain-of-custody form. The chain of custody begins at the time of sample collection. The laboratory will provide forms that will be used for chain-of-custody documentation.

A sample is under custody if:

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

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

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

The Tetra Tech FOL is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a shipping courier. When transferring samples, the individuals relinquishing and receiving the samples will each sign the chain-of-custody form. The date and time will be recorded to each time the samples change hands. Once delivered to the laboratory, internal sample custody procedures will be followed as defined in the laboratory SOPs.

27.6.1 Field Sampling Custody Requirements

Field Sample Custody Procedures (sample collections, packaging, and shipping to laboratory) will be conducted according to Tetra Tech SOP SA-6.3 (Appendix B). Following sample collections in the appropriate bottle ware, all samples will be immediately placed on ice in a cooler. The glass sample containers will be enclosed in bubble wrap to protect the bottle ware during shipment and to prevent cross contamination should a bottle break in transit. The cooler will be secured using duct tape or clear

packaging tape along with two signed custody seals. Sample coolers will be delivered to a local courier location for priority overnight delivery to the selected laboratory for analysis.

The Tetra Tech FOL is responsible for the care and custody of the samples until they are delivered to the laboratory or are entrusted to a carrier. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time on the chain-of-custody form. This form documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common carrier).

27.6.2 Laboratory

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be used according to laboratory specific SOPs. Coolers are received and checked for proper temperature. A sample cooler receipt form will be filled out to note conditions and any discrepancies. The chain-of-custody form will be checked against the sample containers for accuracy. Samples will be logged into the Laboratory Information Management System (LIMS) and given a unique log number which can be tracked through processing. The Laboratory PM will notify the Tetra Tech FOL verbally or via e-mail of any problems on the same day that an issue is identified.

SAP Worksheet No. 28 -- Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix	Groundwater, Soil and Aqueous Field QC Samples
Analytical Group	cVOCs and TCL VOCs
Analytical Method/SOP Reference	SW-846 8260B Empirical SOP-202

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	DQ	MPC
Method Blank	One per preparation batch of 20 or fewer samples of similar matrix.	No analytes > ½ LOQ, except common lab contaminants, which must be < LOQ.	Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Evaluate the samples and associated QC: if blank results are above LOQ, then report sample results which are < LOQ or > 10X the blank concentration. Reanalyze blank and samples >LOQ and < 10X the blank.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits.
Surrogate	Four per sample: Dibromofluoromethane 1,2-dichloroethane-d4 Toluene-d8 BFB	Percent Recoveries (%Rs) must meet the Department of Defense Quality Systems Manual for Environmental Laboratories (DoD QSM) Version 4.2 limits as per Appendix G of the DoD QSM.	If sample volume is available, then re-prepare and reanalyze for confirmation of matrix interference when appropriate.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
Laboratory Control Sample (LCS) / Laboratory Control Sample Duplicate (LCSD) (not required)	One is performed for each batch of up to 20 samples.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM. If LCSD performed - The RPD between LCS and LCSD must be ≤ 30%.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to DOD Quality System Manual (QSM) Version 4.1 Table G-1 for number of marginal exceedances allowed. Contact Client if samples cannot be reprepared within hold time.	Analyst, Supervisor	Accuracy/ Bias Precision also, if LCSD is analyzed	Same as QC Acceptance Limits.

Matrix	Groundwater, Soil and Aqueous Field QC Samples
Analytical Group	cVOCs and TCL VOCs
Analytical Method/SOP Reference	SW-846 8260B Empirical SOP-202

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	DQ	MPC
MS/MSD	One per sample delivery group (SDG) or every 20 samples of similar matrix.	%Rs should meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM. The RPD between MS and MSD should be ≤ 30%.	Corrective actions will not be taken for samples when recoveries are outside limits and surrogate and Laboratory Control Sample (LCS) criteria are met. If both the LCS and MS/MSD %Rs are unacceptable, then re-prepare the samples and QC.	Analyst, Supervisor	Accuracy/ Bias/ Precision	Same as QC Acceptance Limits.

Matrix	Groundwater, Soil and Aqueous Field QC Samples
Analytical Group	cVOCs and TCL VOCs
Analytical Method/SOP Reference	SW-846 8260B Empirical SOP-202

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	DQ	MPC
Internal Standard (IS)	Three per sample- Fluorobenzene Chlorobenzene-d5 1,4-dichlorobezene-d4	Retention times (RTs) for ISs must be within ± 30 seconds and the IS response areas must be within -50% to +100% of the midpoint standard of the initial calibration (ICAL) curve.	Inspect mass spectrometer or gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
Results between DL and LOQ	NA	Apply "J" qualifier to results detected between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits.

Matrix	Soil, Groundwater, and Aqueous QC Samples
Analytical Group	TCL SVOCs (including low level PAHs)
Analytical Method / SOP Reference	SW-846 8270D-Low Empirical SOP-201

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of 20 or fewer samples of similar matrix.	All target analytes must be ≤ ½ LOQ, except common lab contaminants, which must be < LOQ.	Correct problem. If required, reprepare and reanalyze method blank and all samples processed with the contaminated blank.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits
LCS	One per preparatory batch of 20 or fewer samples of similar matrix.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact Client if samples cannot be reanalyzed within hold time.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
MS/MSD	One per preparatory batch of 20 or fewer samples of similar matrix.	%Rs must meet the DoD QSM Version 4.21 limits as per Appendix G of the DoD QSM. The RPD between MS and MSD should be ≤ 30%.	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met, unless RPDs indicate obvious extraction/ analysis difficulties, then re-prepare and reanalyze MS/MSD.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
IS	Every field sample, standard, and QC sample - six per sample 1,4-Dichlorobenzene-d_4 Naphthalene-d_8 Acenaphthene-d_{10} Phenanthrene-d_{10} Chrysene-d_{12} Perylene-d_{12}.	RTs must be within ± 30 seconds and the response areas must be within -50% to +100% of the ICAL midpoint standard for each IS.	Re-analyze affected samples.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits

Matrix	Soil, Groundwater, and Aqueous QC Samples
Analytical Group	TCL SVOCs (including low level PAHs)
Analytical Method / SOP Reference	SW-846 8270D-Low Empirical SOP-201

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogates	All field and QC samples - six per sample 2-Fluorophenol Phenol-d_6 Nitrobenzene-d_5 2-Fluorobiphenyl 2,4,6-Tribromophenol Terphenyl-d_{14}.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM	(1) Check chromatogram for interference; if found, then flag data. (2) If not found, then check instrument performance; if problem is found, then correct and reanalyze sample. (3) If still out, then re-extract and reanalyze sample. (4) If reanalysis is out, then flag data.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Results between DL and LOQ	NA.	Apply “J” qualifier to results detected between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits

Matrix	Soil, Groundwater, and Aqueous QC Samples
Analytical Group	TCL Pesticides/ PCBs
Analytical Method / SOP Reference	SW-846 8081B, 8082A/ Empirical SOP-211

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of 20 or fewer samples of similar matrix.	All target analytes must be ≤ ½ LOQ.	Correct problem. If required, reprepare and reanalyze method blank and all samples processed with the contaminated blank.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits
LCS	One per preparatory batch of 20 or fewer samples of similar matrix. Pesticide: Spike with single component pesticide mix PCB: Spike with Aroclor 1016/1260 mix	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact client if samples cannot be reanalyzed within hold time.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
MS/MSD	One per preparatory batch of 20 or fewer samples of similar matrix. Spike same as LCS.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM. The RPD between MS and MSD should be ≤ 30%.	Evaluate the samples and associated QC and if the LCS results are acceptable, then narrate. If both the LCS and MS/MSD are unacceptable, then re-prepare the samples and QC.	Analyst, Supervisor	Accuracy/ Bias/ Precision	Same as QC Acceptance Limits

Matrix	Soil, Groundwater, and Aqueous QC Samples
Analytical Group	Pesticides/ PCBs
Analytical Method / SOP Reference	SW-846 8081B, 8082A/ Empirical SOP-211

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogates	All field and QC samples - two per sample tetrachloro-m-xylene decachlorobiphenyl.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM.	No corrective will be taken when one surrogate is within criteria. If surrogates recoveries are high and sample is <LOQ, then no CA is taken. If surrogates recoveries are low, then the affected samples are re-extracted and reanalyzed.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Second Column Confirmation	All positive results must be confirmed.	Results between primary and secondary column must be RPD ≤ 40%. For Method 8082, report the higher of the two concentrations, unless there is interference.	None. Apply "J" flag if RPD >40% and discuss in the case narrative.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits
Results between DL and LOQ	NA.	Apply "J" qualifier to results between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits

Matrix	Soil, Groundwater and Aqueous Field QC Samples
Analytical Group	Metals (including Mercury and Dissolved Iron and Manganese)
Analytical Method/SOP Reference	SW-846 6010C, 7470A, 7471B/ Empirical SOP-103, 104, 105

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per digestion batch of 20 or fewer samples.	No analytes detected > ½ the LOQ.	If the blank value > LOQ, then report sample results. If the blank value < LOQ or > 10x the blank value; then redigest. If blank value is less than negative LOQ, then report sample results. If > 10x the absolute value of the blank result, then redigest.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits.
LCS	One is performed for each batch of up to 20 samples.	The %R must be within 80-120%.	Redigest and reanalyze all associated samples for affected analyte.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
MS	One per preparation batch of 20 or fewer samples of similar matrix.	%R should be within 80-120% of true value (if sample is < 4x spike added).	Flag results for affected analytes for all associated samples with “N”.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
Duplicate Sample	One per preparation batch of 20 or fewer samples of similar matrix.	The RPD should be within ≤20% for duplicate samples for both water and soils.	Narrate any results that are outside control limits.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits.

Matrix	Soil, Groundwater and Aqueous Field QC Samples
Analytical Group	Metals (including Mercury and Dissolved Iron and Manganese)
Analytical Method/SOP Reference	SW-846 6010C, 7470A, 7471B/ Empirical SOP-103, 104, 105

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Serial Dilution (applies to ICP only)	One is performed for each preparation batch with sample concentration(s) > 50x LOQ.	The 5-fold dilution result must agree within ±10 percent difference of the original sample result if result is >50x LOD.	Perform Post Digestion Spike.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits.
Post Digestion Spike (applies to ICP only)	One is performed when serial dilution fails or target analyte concentration(s) in all samples are < 50x LOD.	The %R must be within 75-125% of expected value to verify the absence of interference. Spike addition should produce a concentration of 10-100x LOQ.	Flag results for affected analytes for all associated samples with "J".	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
Results between DL and LOQ	NA.	Apply "J" qualifier to results between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits.

Matrix	Groundwater
Analytical Group	Dissolved Gases
Analytical Method/ SOP Reference	RSK SOP 175 Microseeps SOP-AM20GAx

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per batch of up to 20 samples.	Analyte concentration must be <½ LOQ.	Correct problem, re-prepare and reanalyze along with all associated samples.	Analyst, Supervisor, and Data Validator	Bias/ Contamination	Same as QC Acceptance Limits.
LCS	One per batch of up to 20 samples.	%R must be within 80-120% of the true value.	Correct problem, reprepare, and reanalyze the LCS along with all associated samples.	Analyst, Supervisor, and Data Validator	Accuracy/ Bias	Same as QC Acceptance Limits.
MS/MSD	One per batch of up to 20 samples.	%R should be within 80-120% of the true value. RPD between MS and MSD should be ≤ 20%.	Contact client for guidance.	Analyst, Supervisor, and Data Validator	Accuracy/ Bias Precision	Same as QC Acceptance Limits.

Matrix	Groundwater
Analytical Group	Anions
Analytical Method/SOP Reference	EPA 300.0 Empirical SOP-145

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per batch of up to 20 samples.	Analyte concentration must be <½ LOQ.	Correct problem, re-prepare, and reanalyze along with all associated samples.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits.
LCS	One per batch of up to 20 samples.	%R must be within 80-120% of true value.	Correct problem, re-prepare, and reanalyze the LCS along with all associated samples.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
Sample Duplicate (Replicate)	One per every 10 samples.	RPD must be ≤ 10%.	Correct problem and reanalyze sample and duplicate.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits.
MS/MSD	One per batch of up to 20 samples.	%R should be within 80-120% of true value. RPD between MS and MSD should be ≤ 10%.	Contact client for guidance.	Analyst, Supervisor	Accuracy/ Bias Precision	Same as QC Acceptance Limits.

Matrix	Groundwater
Analytical Group	BOD
Analytical Method/SOP Reference	SM5210B Empirical SOP-163

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per batch of up to 20 samples.	Analyte concentration must be < LOQ.	Correct problem, re-prepare, and reanalyze along with all associated samples.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits.
LCS	One per batch of up to 20 samples.	%R must be within 80-120% of true value.	Correct problem, re-prepare, and reanalyze the LCS along with all associated samples.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
MS/MSD	One per batch of up to 20 samples.	%R must be within 80-120% of true value. RPD between MS and MSD should be ≤ 20%.	Contact client for guidance.	Analyst, Supervisor	Accuracy/ Bias Precision	Same as QC Acceptance Limits.

Matrix	Groundwater
Analytical Group	COD
Analytical Method/SOP Reference	EPA 410.4 Empirical SOP-169

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per batch of up to 20 samples.	Analyte concentration must be < LOQ.	Correct problem, re-prepare, and reanalyze along with all associated samples.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits.
LCS	One per batch of up to 20 samples.	%R must be within 80-120% of true value.	Correct problem, re-prepare, and reanalyze the LCS along with all associated samples.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
MS/MSD	One per batch of up to 20 samples.	%R must be within 80-120% of true value. RPD between MS and MSD should be ≤ 20%.	Contact client for guidance.	Analyst, Supervisor	Accuracy/ Bias Precision	Same as QC Acceptance Limits.

Matrix	Groundwater
Analytical Group	Alkalinity
Analytical Method/SOP Reference	SM2320B Empirical SOP-154

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per batch of up to 20 samples.	Analyte concentration must be <½ LOQ.	Correct problem, re-prepare, and reanalyze along with all associated samples.	Analyst, Supervisor	Contamination/ Bias	Same as QC Acceptance Limits.
Calibration Blank	At the beginning of analytical sequence, after every 10 samples, and at the end of the sequence.	Analyte concentration must be < 2x DL.	Correct problem, re-prepare, and reanalyze along with all associated samples.	Analyst, Supervisor	Contamination/ Bias	Same as QC Acceptance Limits.
LCS	One per batch of up to 20 samples.	%R must be within 90-110% of true value.	Correct problem, re-prepare, and reanalyze the LCS along with all associated samples.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
MS/MSD	One per batch of 20 or fewer samples per matrix.	%R should be within 90-110% of true value. RPD between MS and MSD should be ≤ 20%.	Contact client for guidance.	Analyst, Supervisor	Accuracy/ Bias Precision	Same as QC Acceptance Limits.

Matrix	Groundwater
Analytical Group	Hexavalent Chromium
Analytical Method/SOP Reference	EPA 218.6/ CAS SOP GEN-7199

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	1 per batch of 20 or fewer samples.	No target compounds should be >1/2 LOQ	Reclean, reanalyze and/or qualify the data.	Analyst, Supervisor	Bias/Contamination	Same as QC Acceptance Limits.
MS	1 per batch of 20 or fewer samples.	90-110% of True Value.	If LCS acceptable, may report with qualifier and note outliers in the case narrative.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
LCS	1 per batch of 20 or fewer samples.	90-110% of True Value.	Evaluate, reanalyze batch if possible. If the LCS recoveries are high and the sample results are <QL narrate.	Analyst, Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
MSD	1 per batch of 20 or fewer samples.	RPD<20%; +/- RL if <4xLOQ.	Repeat sample and duplicate unless obvious or historical interferences or lack of volume.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits.

Matrix	Soil
Analytical Group	Hexavalent Chromium
Analytical Method/SOP Reference	SW-846 7199/ CAS SOP GEN-7199

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for Corrective Action	DQI	MPC
Method Blank	1 per batch of 20 or fewer samples	No target compounds should be >1/2 LOQ.	Reclean, reanalyze and/or qualify the data	Analyst, Supervisor	Bias/Contamination	Same as QC Acceptance Limits.
MS-soluble	1 per batch of 20 or fewer samples	75-125% of True Value.	Redigest entire batch unless spike is diluted out (sample result > 4x spike concentration). If redigest fails, contact client about possible matrix investigations. If samples are out of holding time, redigest and report both sets of data. If insufficient sample is available to redigest, flag. Flag results associated with out of control matrix spike.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.

Matrix	Soil
Analytical Group	Hexavalent Chromium
Analytical Method/SOP Reference	SW-846 7199/ CAS SOP GEN-7199

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for Corrective Action	DQI	MPC
MS-insoluble	1 per batch of 20 or fewer samples	75-125% of True Value.	Redigest entire batch unless spike is diluted out (sample result > 4x spike concentration). If redigest fails, contact client about possible matrix investigations. If samples are out of holding time, redigest and report both sets of data. If insufficient sample is available to redigest, flag. Flag results associated with out of control matrix spike.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits.
LCS-insoluble	1 per batch of 20 or fewer samples	80-120% of True Value.	Redigest if possible. If samples are out of holding time, redigest and report both sets of data. If insufficient sample is available to redigest, flag. If the LCS recoveries are high and the sample results are <QL narrate.	Analyst, Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.

Matrix	Soil
Analytical Group	Hexavalent Chromium
Analytical Method/SOP Reference	SW-846 7199/ CAS SOP GEN-7199

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for Corrective Action	DQI	MPC
MSD	1 per batch of 20 or fewer samples	RPD<20%; +/- RL if <4xLOQ.	Repeat sample and duplicate unless obvious or historical interferences or lack of volume.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits.
Post Digestion Matrix Spike	1 per batch of 20 or fewer samples	85-115% of True Value	If MS also failed, no action beyond CA for MS.	Analyst, Supervisor	Bias	Same as QC Acceptance Limits.

Matrix	Groundwater and Soil
Analytical Group	pH
Analytical Method / SOP Reference	SW-846 9040Cand 9045C/ CAS-SOP GEN-4500H+B and GEN-9045C

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Laboratory Duplicate	One per preparation batch of 20 or fewer samples.	± 0.1 units	Correct problem, reprepare and reanalyze along will associated samples.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits

Matrix	Groundwater and Soil
Analytical Group	ORP
Analytical Method / SOP Reference	ASTM D1498/CAS SOP GEN-REDOX

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Laboratory Duplicate	One per preparation batch of 20 or fewer samples.	Must be within +/- 20 RPD for aqueous samples. There are no criteria for soil samples.	If water sample exceed 20% RPD, then repeat the sample and duplicate unless there is assignable matrix interference, historical failures or lack of volume.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits

SAP Worksheet No. 29 -- Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

Document	Where Maintained
Sample Collection Documents and Records: • Field logbook (and sampling notes) • Field sample forms (e.g., boring logs, sample log sheets, drilling logs, etc.) • Chain-of-custody records • Sample shipment airbills • Equipment calibration logs • Photographs • Field task modification forms • Sampling and analysis plan • Field Sampling SOPs	Field documents will be maintained in the project file located in the Tetra Tech Tallahassee, Florida office.
Laboratory Documents • Sample receipt, custody, and tracking record • Equipment calibration logs • Sample preparation logs • Analysis Run logs • Corrective Action forms • Reported field sample results • Reported results for standards, QC checks, and QC samples • Extraction/clean-up records • Raw data	Laboratory documents will be included in the hardcopy and portable documents format deliverables from the laboratory. Laboratory data deliverables will be maintained in the Tetra Tech Pittsburgh, Pennsylvania office project file and in long-term data package storage at a third-party professional document storage firm. Electronic data results will be maintained in a database on a password protected Structured Query Language server.
Data Assessment Documents and Records: • Field Sampling Audit Checklist (if an audit is conducted) • Analytical Audit Checklist (if an audit is conducted) • Data Validation Memoranda • All Versions of Project Reports	All assessment documents will be maintained in the Tetra Tech Tallahassee, Florida office.
All project documents and records will be maintained in the NAS Pensacola Administrative Record Repository for the duration the site is listed on the National Priorities List.	

SAP Worksheet No. 30 -- Analytical Services Table

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory/ Organization (name and address, contact person and telephone number)
Soil	TCL VOCs	See Worksheet No. 18	SW-846 8260B	21 calendar days	Brian Richard brichard@empirlabs.com Empirical Laboratories, LLC 621 Mainstream Drive, Suite 270 Nashville, TN 37228 877-345-1113 Ext. 249	NA
	TCL SVOCs (including low level PAHs)		SW-846 8270D low level scan			
	TCL Pesticides and PCBs		SW-846 8081B/8082A			
	TAL Metals (including Mercury)		SW-846 6010C/7471B			
Groundwater and aqueous QC blanks	cVOCs		SW-846 8260B			
	TCL VOCs		SW-846 8260B			
	TCL SVOCs (including low level PAHs)		SW-846 8270D low level scan			
	TCL Pesticides and PCBs		SW-846 8081B/8082A			
	TAL Metals (including Mercury)		SW-846 6010C/7471B			
	Dissolved Iron and Manganese		SW-846 6010C			
	Anions (nitrate, nitrite, chloride, and sulfate)		EPA 300.0			

Matrix	Analytical Group	Sample Locations/ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory/ Organization (name and address, contact person and telephone number)
Groundwater and aqueous QC blanks	BOD	See Worksheet No. 18	SM 5210B	21 calendar days	Brian Richard brichard@empirlabs.com Empirical Laboratories, LLC 621 Mainstream Drive, Suite 270 Nashville, TN 37228 877-345-1113 Ext. 249	NA
	COD		EPA 410.4			
	Alkalinity		SM 2320B			
Soil	Hexavalent chromium	See Worksheet No. 18	SW-846 7199	21 calendar days	Michael Perry mperry@caslab.com Columbia Analytical Services 1565 Jefferson Road, Building 300, Suite 360 Rochester, NY 14623 585-288-5380	NA
	pH		SW-846 9045C			
	ORP reported as Eh		ASTM D1498			
Groundwater	Hexavalent chromium		EPA 218.6			
	pH		SW-846 9045C			
	ORP reported as Eh		ASTM D1498			
Groundwater	Dissolved Gases (including hydrogen)	See Worksheet No. 18	RSK SOP 175	21 calendar days	Debbie Hallo dhallo@microseeps.com Microseeps Inc. 220 William Pitt Way Pittsburgh, PA 15238 412-826-5245	NA
Groundwater	CSIA and qPCR	See Worksheet No. 18	Laboratory Proprietary	21 calendar days	Anita Biernacki Microbial Insights 2340 Stock Creek Boulevard Rockford, TN 37853-3044 (865) 573-8188, x108	NA

SAP Worksheet No. 31 -- Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

ASSESSMENT TYPE	FREQUENCY	INTERNAL OR EXTERNAL	ORGANIZATION PERFORMING ASSESSMENT	PERSON(S) RESPONSIBLE FOR PERFORMING ASSESSMENT (title and organizational affiliation)	PERSON(S) RESPONSIBLE FOR RESPONDING TO ASSESSMENT FINDINGS (title and organizational affiliation)	PERSON(S) RESPONSIBLE FOR IDENTIFYING AND IMPLEMENTING CA (title and organizational affiliation)	PERSON(S) RESPONSIBLE FOR MONITORING EFFECTIVENESS OF CA (title and organizational affiliation)
Laboratory System Audit[1]	Every two years	External	DoD ELAP Accrediting Body	DoD ELAP Accrediting Body Auditor	Laboratory QAM or Laboratory Manager, Empirical and Columbia Analytical Services	Laboratory QAM or Laboratory Manager, Empirical and Columbia Analytical Services	Laboratory QAM or Laboratory Manager, Empirical and Columbia Analytical Services
Peer Review of Work Plans and Reports	Draft, Draft Final and Final Documents	Internal	Tetra Tech	Technical Experts and Technical Editors	Report Author	Project Manager	Project Manager

1 Empirical and Columbia Analytical Services is DoD ELAP accredited by a recognized Accrediting Body. The DoD ELAP accreditation letter is included in Appendix C.

Microseeps is a NELAP accredited laboratory for these analyses. A copy of Microseeps' accreditation can be found in Appendix C.

Microbial Insights will perform analysis for qPCR. No state or DoD accreditation is required for these analyses.

Advanced diagnostic tools, including qPCR, CSIA, and SIP will only be used during the third sampling event if, based on their review of the first two sampling events, the NAS Pensacola Partnering Team decides such additional lines of evidence are necessary to support the efficacy of MNA.

SAP Worksheet No. 32 -- Assessment Findings and Corrective Action Responses

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	**Nature of Deficiencies Documentation**	**Individual(s) Notified of Findings** (name, title, organization)	**Timeframe of Notification**	**Nature of Corrective Action Response Documentation**	**Individual(s) Receiving Corrective Action Response** (name, title, organization)	**Timeframe for Response**
Laboratory System Audit	Written audit report	Marcia McGinnity, Laboratory QAM, Empirical Lisa Reyes, Laboratory QAM, Columbia Analytical Services	Specified by DoD ELAP Accrediting Body	Letter	DoD ELAP Accrediting Body	Specified by DoD ELAP Accrediting Body

SAP Worksheet No. 33 -- QA Management Reports Table

(UFP QAPP Manual Section 4.2)

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Data Validation Report	Per sample delivery group (SDG)	Within 3 weeks after receiving the data from the laboratory	Project Chemist or Data Validator, Tetra Tech	PM, Tetra Tech; project file
Project Monthly Progress Report	Monthly for duration of the project	Monthly	PM, Tetra Tech	PM, Tetra Tech; QAM, Tetra Tech; Program Manager, Tetra Tech; Navy RPM; project file
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem (on the same day)	Laboratory PM, Empirical	PM and project file, Tetra Tech

SAP Worksheet No. 34 -- Verification (Step I) Process Table

(UFP-QAPP Manual Section 5.2.1)

VERIFICATION INPUT	DESCRIPTION	INTERNAL/ EXTERNAL	RESPONSIBLE FOR VERIFICATION (name, organization)
Chain-of-Custody Forms	The Tetra Tech FOL or designee will review and sign the chain-of-custody form to verify that the samples listed are included in the shipment to the laboratory and the sample information is accurate. The forms will be signed by the sampler and a copy will be retained for the project file, the Tetra Tech PM, and the Tetra Tech Data Validators.	Internal	Sampler and FOL, Tetra Tech
Chain-of-Custody Forms	The Empirical Sample Custodian will review the sample shipment for completeness, integrity, and sign accepting the shipment. The Tetra Tech Data Validators will check that the chain-of-custody form was signed and dated by the Tetra Tech FOL or designee relinquishing the samples and also by the Laboratory Sample Custodian receiving the samples for analyses.	Internal/ External	1 - Laboratory Sample Custodian, Empirical , Columbia Analytical Services , Microseeps, and Microbial Insights 2 - Data Validators, Tetra Tech
SAP Sample Tables/ Chain-of-Custody Forms	Verify that all proposed samples listed in the SAP tables have been collected.	Internal	FOL or designee, Tetra Tech
Sample Log Sheets	Verify that information recorded in the log sheets is accurate and complete.	Internal	FOL or designee, Tetra Tech
SAP/ Field Logs/ Analytical Data Packages	Ensure that all sampling SOPs were followed. Verify that deviations have been documented and MPCs have been achieved. Particular attention should be given to verify that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken trail of documented chain-of-custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the sampling plan was implemented and carried out as written and that any deviations are documented.	Internal	PM or designee, Tetra Tech
SAP/ Analytical SOPs/ Analytical Data Packages	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied.	Internal	Laboratory QAM, Empirical , Columbia Analytical Services , Microseeps, and Microbial Insights
SAP/ Laboratory SOPs/ Raw Data/ Applicable Control Limits Tables	Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the Laboratory QAM will contact the Tetra Tech PM verbally or via e-mail for guidance prior to report preparation.	Internal	Laboratory QAM, Empirical , Columbia Analytical Services , Microseeps, and Microbial Insights
SAP/ Chain-of-Custody Forms	Check that field QC samples listed in Worksheet No.20 were collected as required.	Internal	FOL or designee, Tetra Tech

VERIFICATION INPUT	DESCRIPTION	INTERNAL/ EXTERNAL	RESPONSIBLE FOR VERIFICATION (name, organization)
Electronic Data Deliverables (EDDs)/Analytical Data Packages	Each EDD will be verified against the chain-of-custody and hard copy data package for accuracy and completeness. Laboratory analytical results will be verified and compared to the electronic analytical results for accuracy. Sample results will be evaluated for laboratory contamination and will be qualified for false positives using the laboratory method/preparation blank summaries. Positive results reported between the DL and the LOQ will be qualified as estimated. Extraneous laboratory qualifiers will be removed from the validation qualifier.	External	Data Validators, Tetra Tech

Notes: Verification includes field data verification and laboratory data verification. Verification inputs as per Worksheet No.34 will be checked.

SAP Worksheet No. 35 -- Validation (Steps IIa and IIb) Process Table

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

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	SAP/ Sample Log Sheets	Sample Coordinates - Ensure that sample locations are correct and in accordance with the SAP proposed locations. Document any discrepancies in the final report.	PM, FOL, or designee, Tetra Tech
IIa	Chain-of-Custody Forms	Custody - Ensure that the custody and integrity of the samples was maintained from collection to analysis, the custody records are complete, and any deviations are recorded. Review that the samples were shipped and store at the required temperature and sample pH for chemically preserved samples meet the requirements listed in Worksheet No.19. Ensure that the analyses were performed within the holding times listed in Worksheet No.19.	Project Chemist or Data Validators, Tetra Tech
IIa/IIb	SAP/ Laboratory Data Packages/ EDDs	Ensure that the laboratory QC samples listed in Worksheet No. 28 were analyzed and that the MPCs listed in Worksheet No. 12 were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.	Project Chemist or Data Validators, Tetra Tech
		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/LCSD, if available.	
		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.	
		Review the chain-of-custody forms generated in the field to ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. The Tetra Tech Data Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Validation will be performed as per Worksheet No. 36.	

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIb	SAP/ Laboratory Data Packages/ EDDs	Ensure that the LOQs listed in Worksheet No. 15 were achieved.	Project Chemist or Data Validators, Tetra Tech
		Discuss the impact of matrix interferences or sample dilutions performed because of the high concentration of one or more other contaminants, on the other target compounds reported as non-detected.	
		Summarize deviations from methods, procedures, or contracts in the Data Validation Report. If possible determine the impact of any deviation from sampling or analytical methods and SOPs requirements and matrix interferences effect on the analytical results. Qualify data results based on method or QC deviation and explain all the data qualifications.	
		Ensure that the laboratory QC samples listed in Worksheet No. 28 were analyzed and that the MPCs listed in Worksheet No. 12 were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.	

SAP Worksheet No. 36 -- Analytical Data Validation (Steps IIa and IIb) Summary Table

(UFP-QAPP Manual Section 5.2.2.1)

STEP IIa / IIb	MATRIX	ANALYTICAL GROUP	VALIDATION CRITERIA	DATA VALIDATOR (title and organizational affiliation)
IIa and IIb	Groundwater, Aqueous QC samples, and Soil	cVOCs, TCL VOCs, TCL SVOCs (including low level PAHs), TCL Pesticides and PCBs	100% limited validation will be performed using criteria for SW-846 Methods 8260B, 8270D, 8081B, and 8082A listed in this SAP and the current DoD QSM. If not included in the aforementioned, the logic outlined in USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review USEPA-540/R-99-008, (USEPA, October 1999) will be used to apply qualifiers to data to the extent possible.	Data Validation Specialist, Tetra Tech
IIa and IIb	Groundwater, Aqueous QC samples, and Soil	TAL Metals (including Mercury) and Dissolved Iron and Manganese	100% limited validation will be performed using criteria for SW-846 Method 6010C, 7470A, and 7471B listed in this Work Plan and the current DoD QSM. If not included in the aforementioned, the logic outlined in USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, October 2004) will be used to apply qualifiers to data to the extent possible.	Data Validation Specialist, Tetra Tech
IIa and IIb	Groundwater,	Dissolved Gases, Anions, BOD, COD, Alkalinity, Hexavalent Chromium, pH, and ORP	100% limited validation will be performed using the method specific criteria listed in this Work Plan to the extent possible will be used.	Data Validation Specialist, Tetra Tech

Limited data validation will be performed. This type of review limits the data review to specific review parameters (Data Completeness/Data Verification, Holding Times, Calibrations, Blank Contamination, & Detection Limits) to determine gross deficiencies only. The limited data validation is best expressed as a review to preclude the possibility of not detecting an analyte that is present in a sample and to eliminate false detections. Raw data are not evaluated and sample result verification is not conducted. A formal report, similar to a full data validation report, is prepared but the scope is more limited than a full validation report. The data packages provided by the laboratory will be expansive enough to allow future complete formal data validation, if necessary.

CSIA and qPCR and reductase genes data will not be validated. (Such data will be collected only during the third sampling event if, based on their review of the first two sampling events, the NAS Pensacola Partnering Team decides such additional lines of evidence are necessary to support the efficacy of MNA.)

SAP Worksheet No. 37 -- Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

Data Usability Assessment
The usability of the data generated during the groundwater investigation directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum, and the results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the evaluator will consult with other technically competent individuals to render sound technical assessments of these DQI characteristics: • **Completeness** For each matrix scheduled to be sampled, the Tetra Tech FOL, acting on behalf of the Project Team, will prepare a table listing to compare planned samples/analyses to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified, the Tetra Tech PM and Project Risk Assessor will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other Project Team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions. • **Precision** The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in Worksheets No. 12 and 28. This will also include a comparison of field and laboratory precision with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met, or if data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report. **Accuracy** The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing percent recoveries of LCS, LCSD, MS, MSD, and surrogate compounds to accuracy goals identified in Worksheet No. 28. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, MSs, and LCSs. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will also be described in the project report. • **Representativeness** A Tetra Tech Project Scientist, identified by the Tetra Tech PM and acting on behalf of the Project Team, will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial and temporal data variations (as applicable), and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Project Scientist indicates that a quantitative analysis is required. • **Comparability** The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether the data generated under this project are sufficiently comparable to historical site data generated by

different methods and for samples collected using different procedures and under different site conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Tetra Tech Project Chemist indicates that such quantitative analysis is required.

- **Sensitivity**

  The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether project sensitivity goals listed in Worksheet No. 15 were achieved. The overall sensitivity and LOQs from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described in the project report. The Tetra Tech Project Chemist may enlist the help of the Project Risk Assessor to evaluate deviations from planned sensitivity goals.

- **Project Assumptions, Data Usability and Data Outliers**

  The data usability assessment is performed at the conclusion of data collection activities, using the outputs from data verification and data validation. It is the data interpretation phase, which involves a qualitative and quantitative evaluation of environmental data to determine if the project data are of the right type, quality, and quantity to support the decisions that need to be made. It involves a retrospective evaluation of the systematic planning process, and, like the systematic planning process, involves participation by key members of the project team. The data usability assessment evaluates whether underlying assumptions used during systematic planning are supported, sources of uncertainty have been accounted for and are acceptable, data are representative of the population of interest, and the results can be used as intended, with the acceptable level of confidence.

  The Tetra Tech PM and designated team members will use the 5 step process presented in Data Quality Assessment: A Reviewer's Guide, EPA QA/G-9, EPA/240/B-06/002, February 2006 (Appendix B) to evaluate whether project assumptions are valid. This will typically be a qualitative evaluation but may be supported by quantitative evaluations. The type of evaluation depends on the assumption being tested. Quantitative assumptions include those related to data distributions (e.g., normal or log-normal) and estimates of data variability. Potential data outliers will be removed if a review of the associated data indicates that the results have an assignable cause that renders them inconsistent with the remainder of the data. During this evaluation, the team will consider whether outliers could be indications of unanticipated site conditions.

Step 1 **Review the project's objectives and sampling design:** Review the key outputs defined during systematic planning (i.e., PQOs or DQOs and MPCs) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.

Step 2 **Review the data verification and data validation outputs:** Review available QA reports, including the data verification and data validation reports. Perform basic calculations and summarize the data (using graphs, maps, tables, etc.). Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant PT sample results, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.

Step 3 **Verify the assumptions of the statistical method(s), if designated to be used:** Verify whether underlying assumptions for selected statistical methods (if documented in the QAPP) are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical

analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.

Step 4 **Implement the statistical method:** Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing (e.g., "concentrations of lead in groundwater are below the action level") consider the consequences for selecting the incorrect alternative; for estimation projects (e.g., establishing a boundary for surface soil contamination), consider the tolerance for uncertainty in measurements.

Step 5 **Document data usability and draw conclusions:** Determine if the data can be used as intended, considering implications of deviations and corrective actions. Discuss data quality indicators. Assess the performance of the sampling design and Identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report which can be in the form of text and/or a table.

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

After the completion of data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these DQI characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples with non-detected results, number of samples with detected results, and the proportion of samples with detected and non-detected results. The Project Team members, identified by the Tetra Tech PM, will assess whether the data collectively support the attainment of project objectives.

Missing or rejected data will be reviewed by the NAS Pensacola team to determine whether it has compromised the ability to make a decision(s) to the desired level of confidence, if it can be compensated for by other data, or if rejected how it can be best used to support the project objectives and decisions.
For statistical comparisons and mathematical manipulations, non-detected values will be represented by a concentration equal to one-half of the sample-specific reporting limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations.

Identify the personnel responsible for performing the usability assessment:

The Tetra Tech PM, Project Chemist, FOL, and Project Scientist will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the NAS Pensacola Partnering Team. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face-to-face meeting or teleconference, depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest resampling or other corrective actions, if necessary.

REFERENCES

ABB-ES (ABB Environmental Services, Inc.), 1993. Contamination Assessment Report, Site 3221SW, February.

Navy (Department of Navy), 1994. Letter from Timothy Thomson NASP Commanding Officer to W. E. Grimsley, Supervisor UST Program Escambia County Health Department. Storage Tank Closure, UST at Building 3221 NAS Pensacola, August 11.

FDEP (Florida Department of Environmental Protection), 2004. Guidance *for the Selection of Analytical Methods and for the Evaluation of Practical Quantitation Limits*. October 12.

FDEP, 2005. *Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.* Prepared for the Division of Waste Management, Florida Department of Environmental Protection; Prepared by Center for Environmental & Human Toxicology, University of Florida, Gainesville, FL. February 26.

FDEP, 2008. *Standard Operating Procedures for Field Activities*. DEP-SOP-001/01. December 3.

IDQTF (Intergovernmental Data Quality Task Force), 2005a (U.S. DoD, U.S. Department of Energy (DOE), USEPA), 2005a. Interagency Data Quality Task Force *Uniform Federal Policy for Quality Assurance Project Plans. Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Parts 1, 2A, 2B, and 2C*. EPA-505-B-04-900A, Final, Version 1. March.

NEESA (Naval Energy and Environmental Support Activity), 1983, Initial Assessment Study of Naval Air Station Pensacola. June.

Tetra Tech (Tetra Tech, Inc.), 2008. Remedial Investigation Report for Site 44 (Former UST Site 3221 SW), NAS Pensacola, Florida, NAVFAC Southeast (SE), October.

Tetra Tech, 2010. Feasibility Study for Operable Unit 19 Site 44 – Former UST Site 3221 SW, NAS Pensacola, NAVFAC SE. April

USDoD (U.S. Department of Defense), 2009. *DoD Quality Systems Manual for Environmental Laboratories*, Version 4.1. April.

USEPA (United States Environmental Protection Agency), 1999. Contract Laboratory Program National Functional Guidelines for Organics Data Review. EPA540/R-99/008. Office of Emergency and Remedial Response, Washington, DC. October.

USEPA. 2002. Guidance for Quality Assurance Project Plans (EPA QA/G-5). EPA/240/R-02/009. USEPA Office of Environmental Information, Washington DC. December.

USEPA, 2004. Contract Laboratory Program National Functional Guidelines for Inorganics Data Review. EPA 540-R-04-004. OSWER 9240.1-45. Office of Superfund Remediation and Technology Innovation (OSRTI), October.

USEPA, 2005. Groundwater Sampling and Monitoring with Direct Push Technologies, Office of Solid Waste and Emergency Response, 9200 1-51, EPA 540/R-04/005. August.

USEPA, 2005. Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Program, Intergovernmental Data Quality Task Force, EPA-505-B-04-900A, Final Version I. March.

USEPA, 2008. Test Methods for Evaluating Solid Waste; Physical/Chemical Methods (SW-846), 3rd Edition, up to and Including Update IV. Office of Solid Waste and Emergency Response, Washington, DC. February.

USEPA, 2011. The Regional Screening Levels for Chemical Contaminants at Superfund Sites Table Update (formally PRGs) Region 9 Specific Information online) http://www.epa.gov/region9/superfund/prg/rsl-table.html November.

FIGURES

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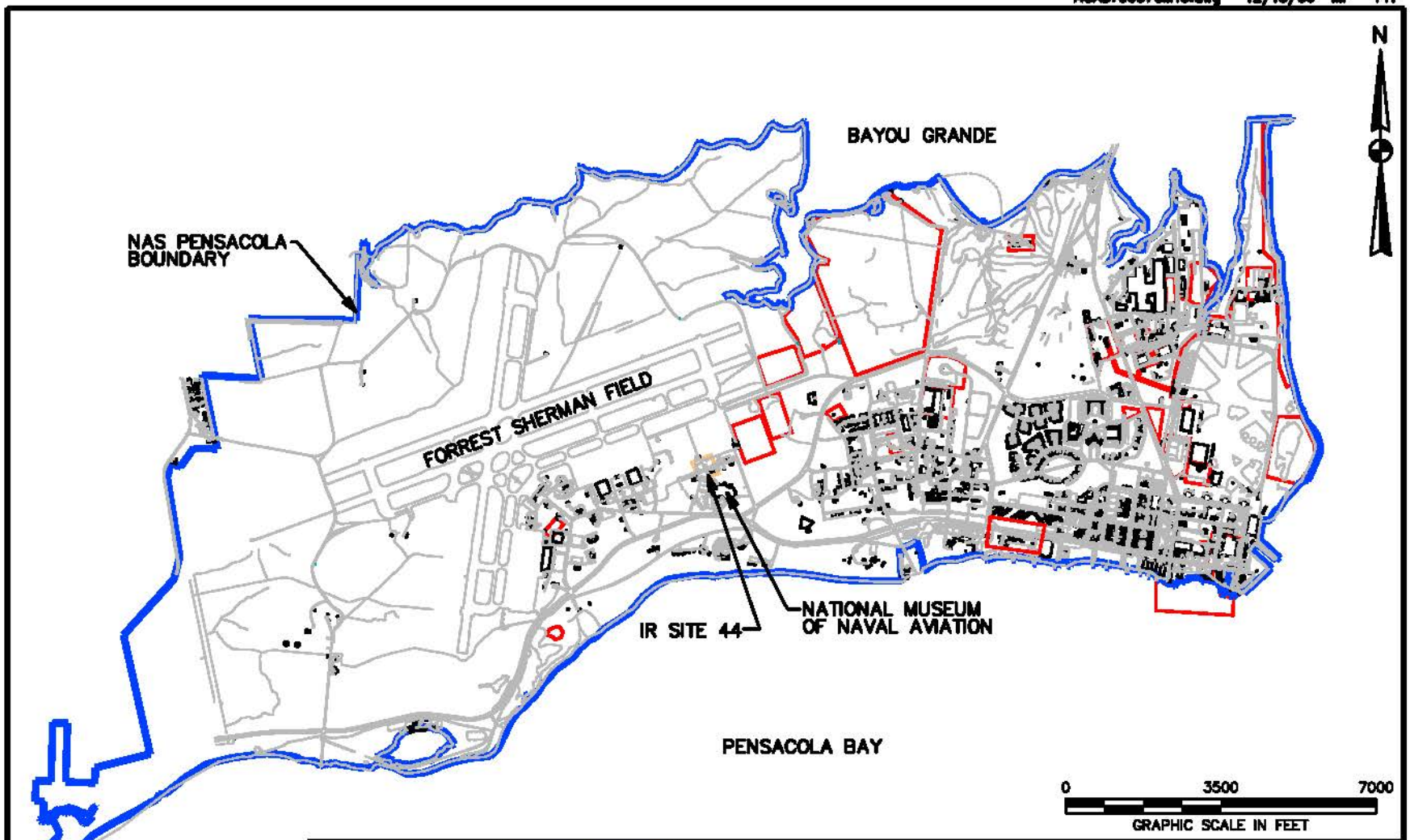

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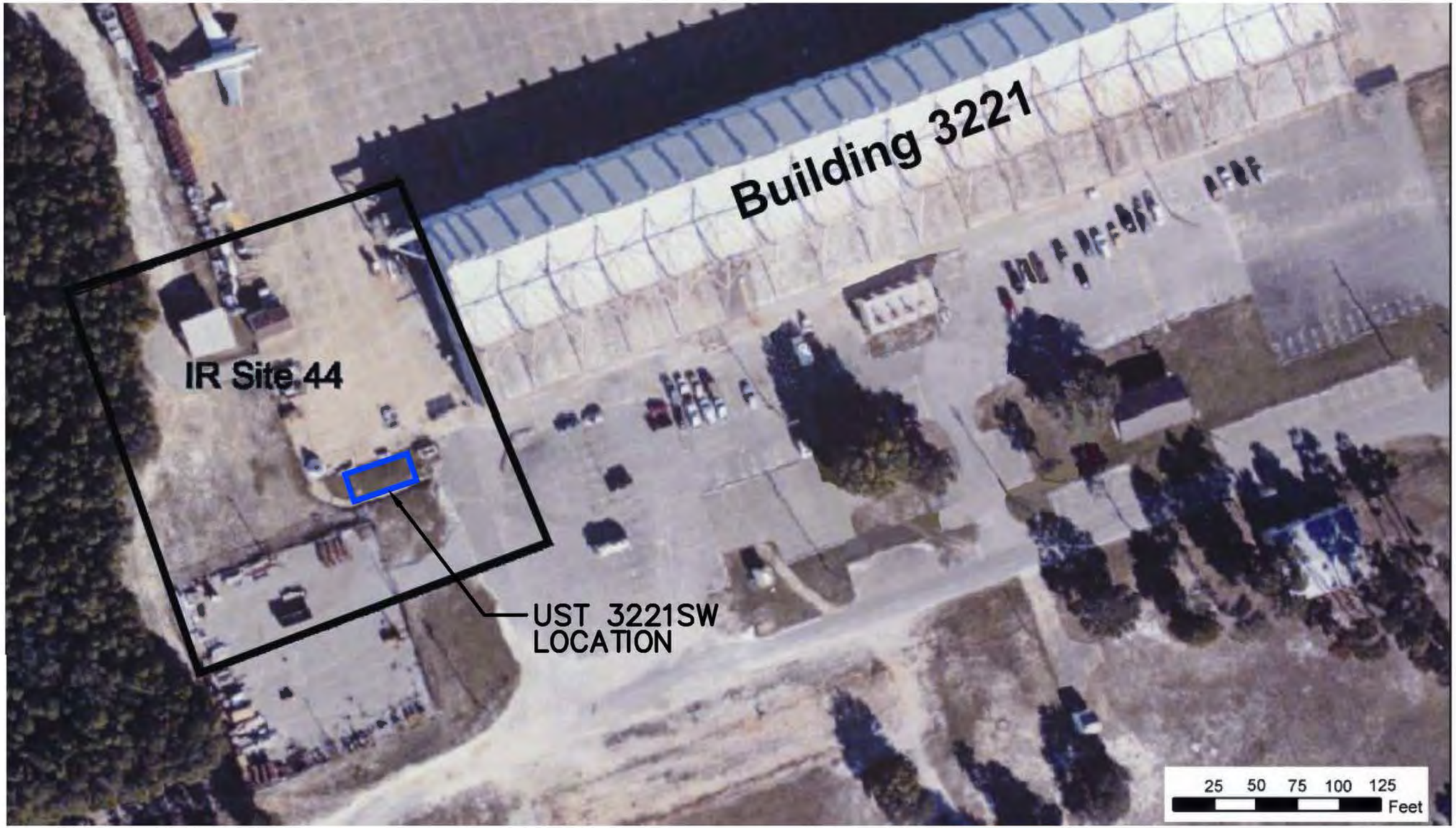

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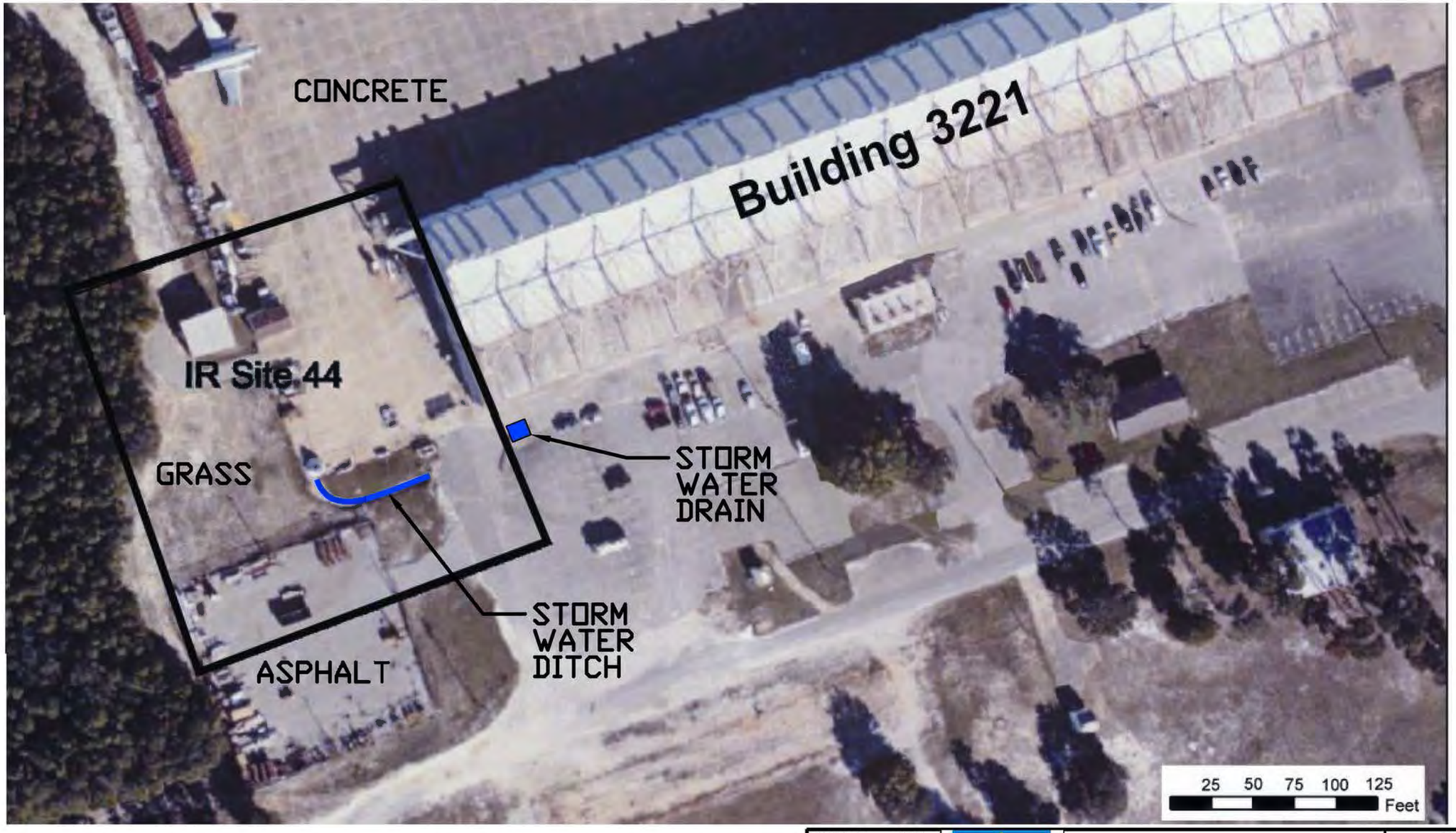

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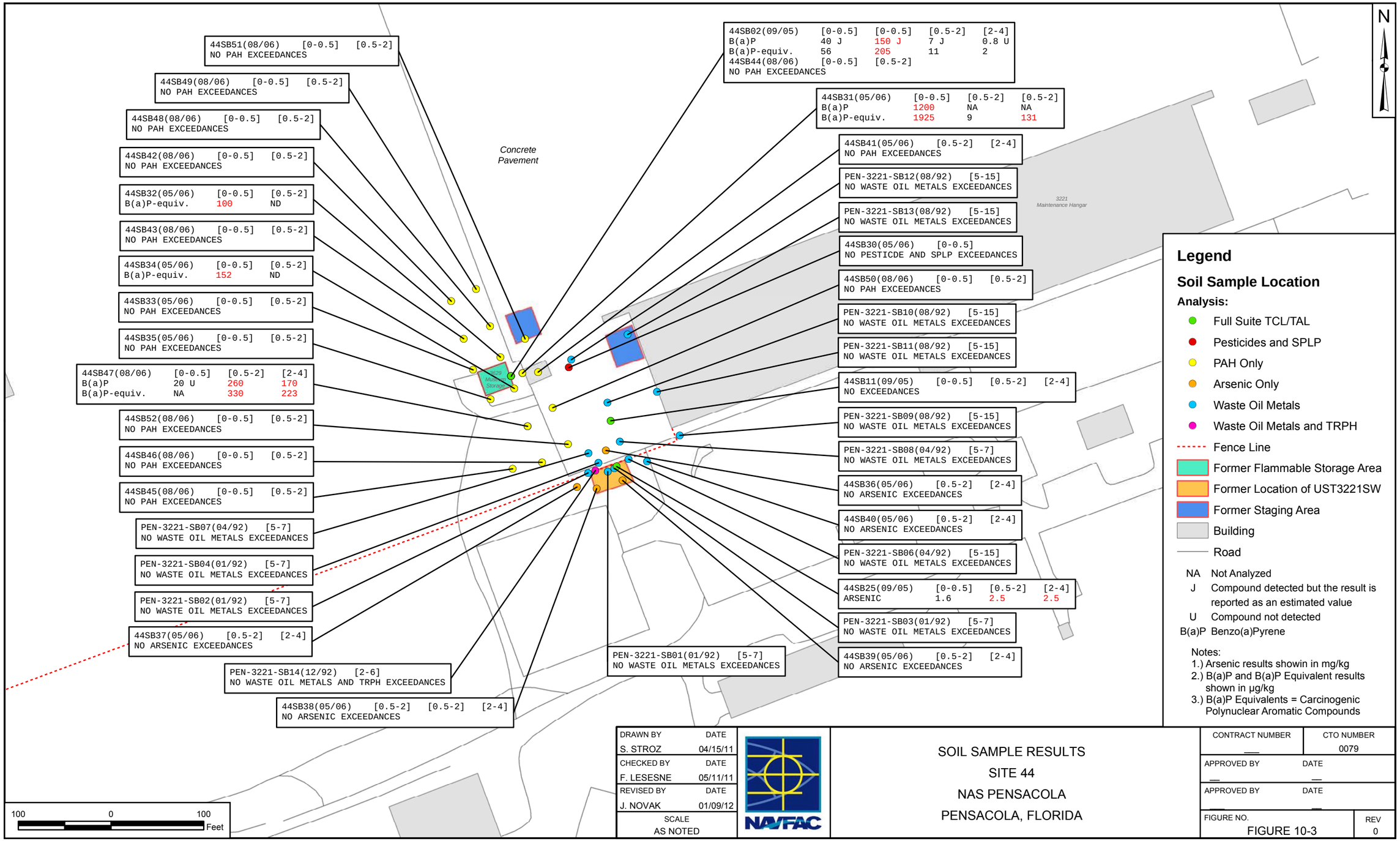

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SOIL SAMPLE RESULTS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
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FIGURE NO.	REV
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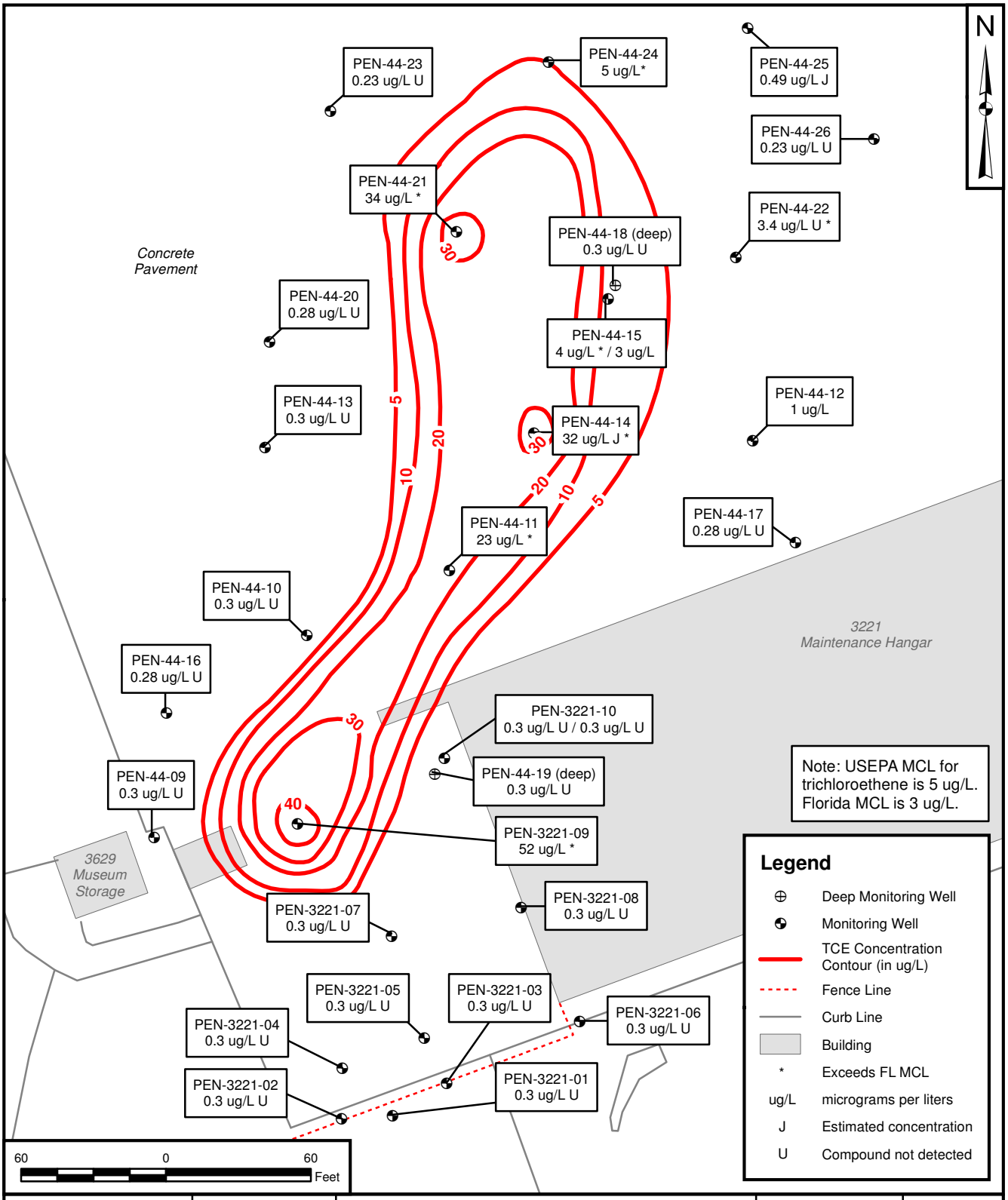

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S. PAXTON	05/02/12
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TRICHLOROETHENE RESULTS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
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FIGURE NO. FIGURE 10-4	REV 0

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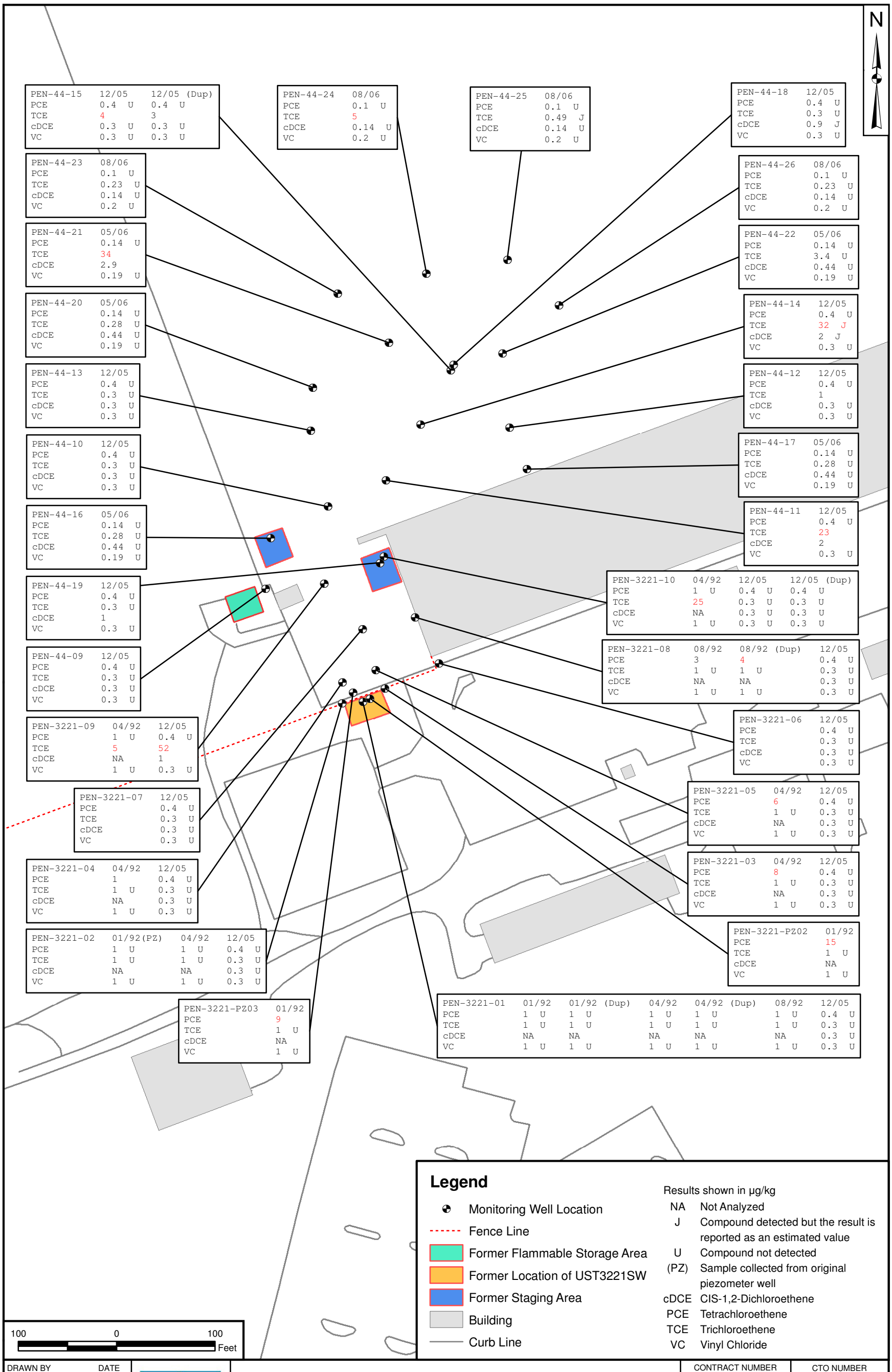

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GROUNDWATER SAMPLE RESULTS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
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FIGURE NO.	REV
FIGURE 10-5	0

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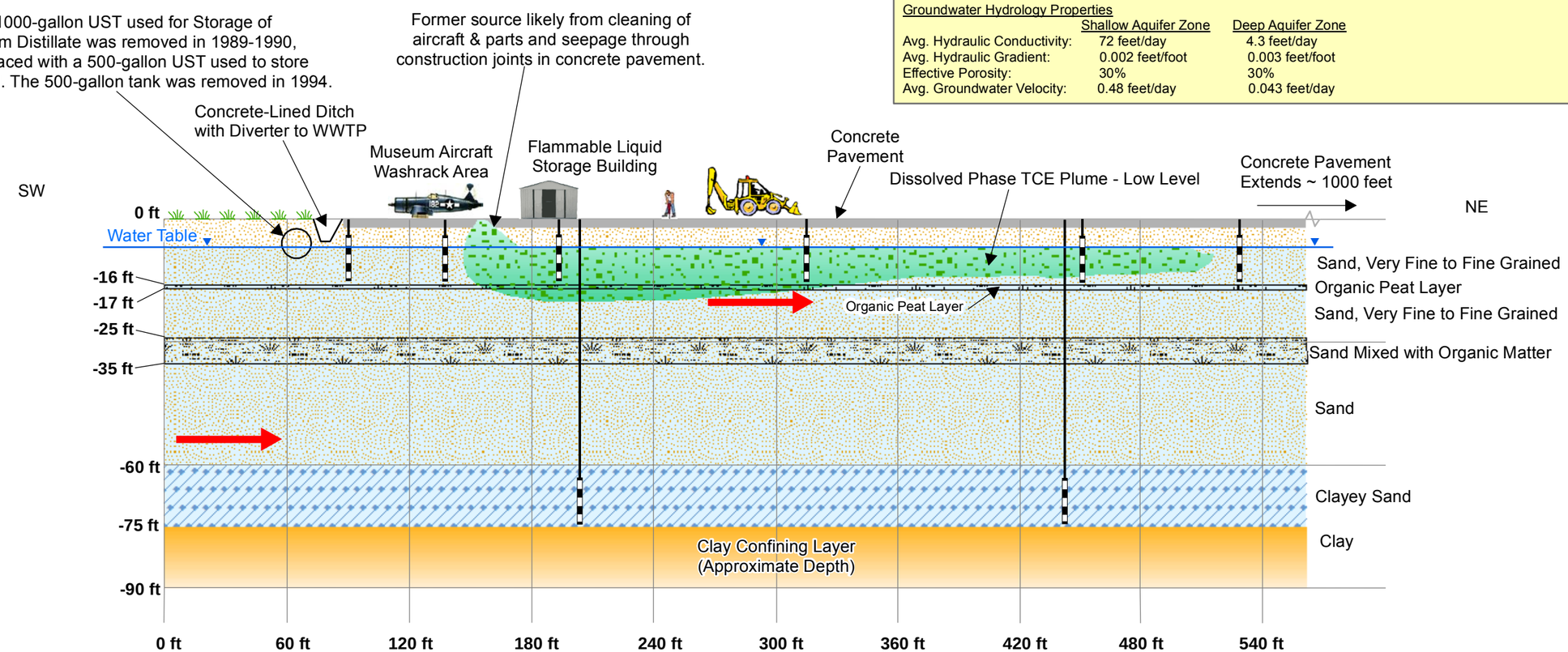
NOTES:
1. In the past, Building 3221 was a hangar and adjacent paved areas were part of the Naval Air Rework Facility. These facilities were used for aircraft maintenance. Building 3221 (Figure 10-5) was evaluated as a potential historical source of groundwater contamination at Site 44. However, soil and groundwater sampling performed during the CAR and RI along the southwest side and northwest corner of the building adjacent to Site 44 indicated Building 3221 is not a source of contamination for the Site 44 groundwater contamination, (Worksheet 10.3.2).
2. The current site is used as a wash rack for cleaning aircraft and aircraft parts that are being refurbished for museum display.
3. Surface drainage in the wash rack area flows to a concrete-lined ditch and is diverted to the WWTP during aircraft washing activities.
4. Current and future land use is industrial (no residential).
5. No potable water use.
6. No ecological habitat.
7. Concrete pavement prevents exposure by site visitors and trespassers.
8. Any potential exposure for excavation/construction workers is managed by LUCs.

Groundwater Hydrology Properties

	Shallow Aquifer Zone	Deep Aquifer Zone
Avg. Hydraulic Conductivity:	72 feet/day	4.3 feet/day
Avg. Hydraulic Gradient:	0.002 feet/foot	0.003 feet/foot
Effective Porosity:	30%	30%
Avg. Groundwater Velocity:	0.48 feet/day	0.043 feet/day



Legend
- Groundwater Flow Direction
- Monitoring Well
- Monitoring Well Screen Interval

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CONCEPTUAL SITE MODEL
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
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FIGURE NO. FIGURE 10-6	REV 0

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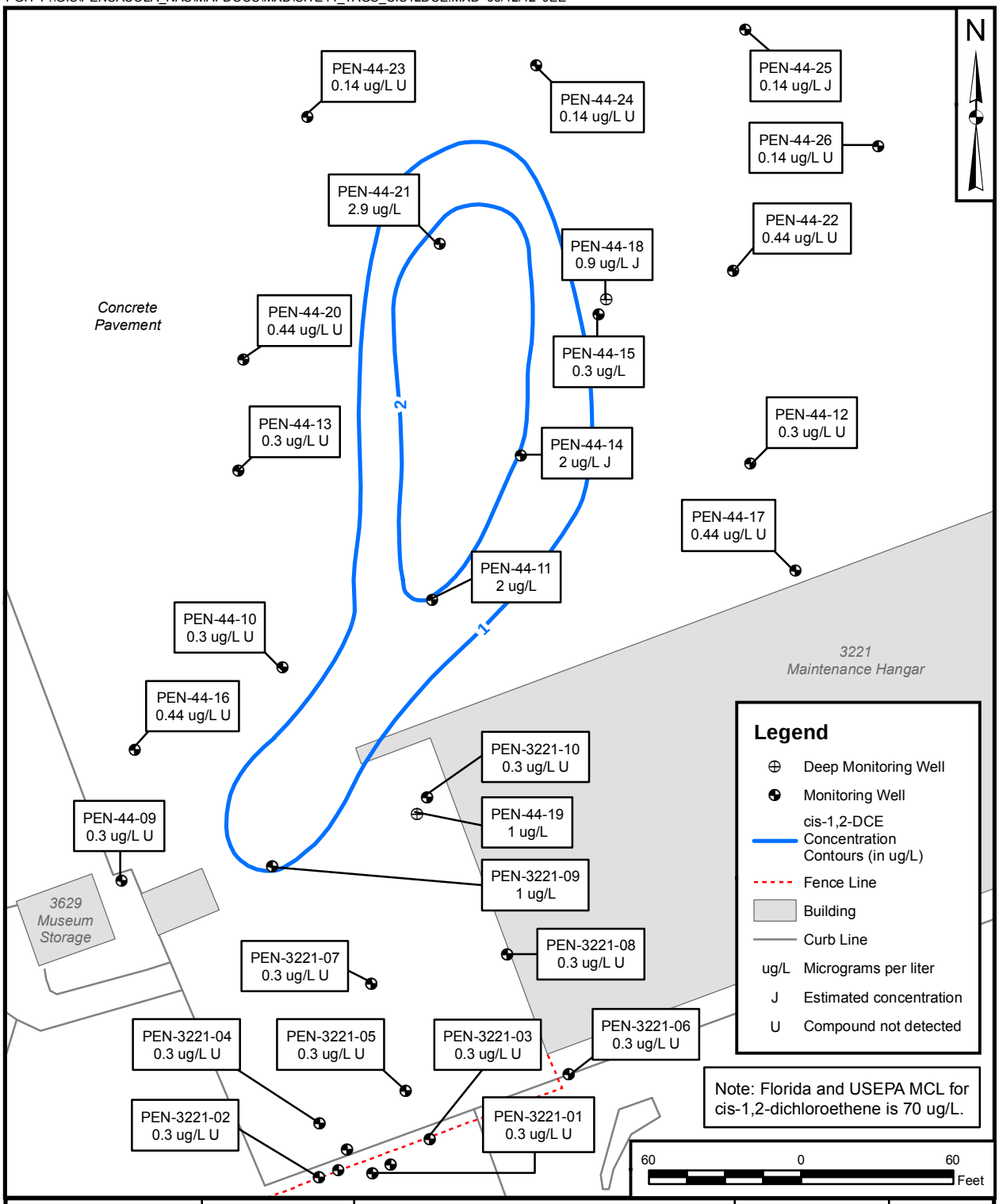

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SCALE AS NOTED			FIGURE NO. FIGURE 10-7	REV 0

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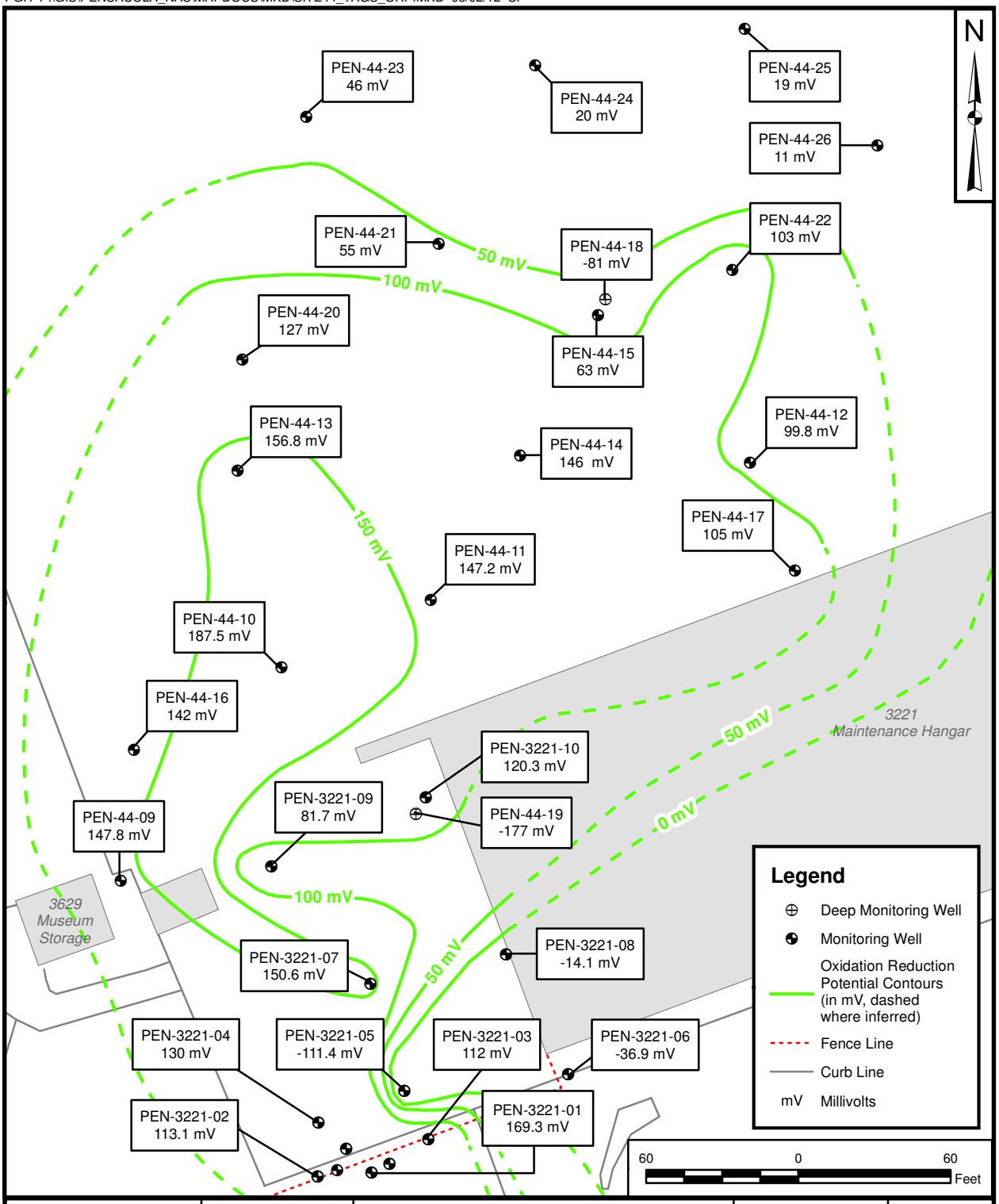

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CHECKED BY F. LESESNE	DATE 05/02/12		APPROVED BY ___	DATE ___
REVISED BY S. PAXTON	DATE 05/02/12		APPROVED BY ___	DATE ___
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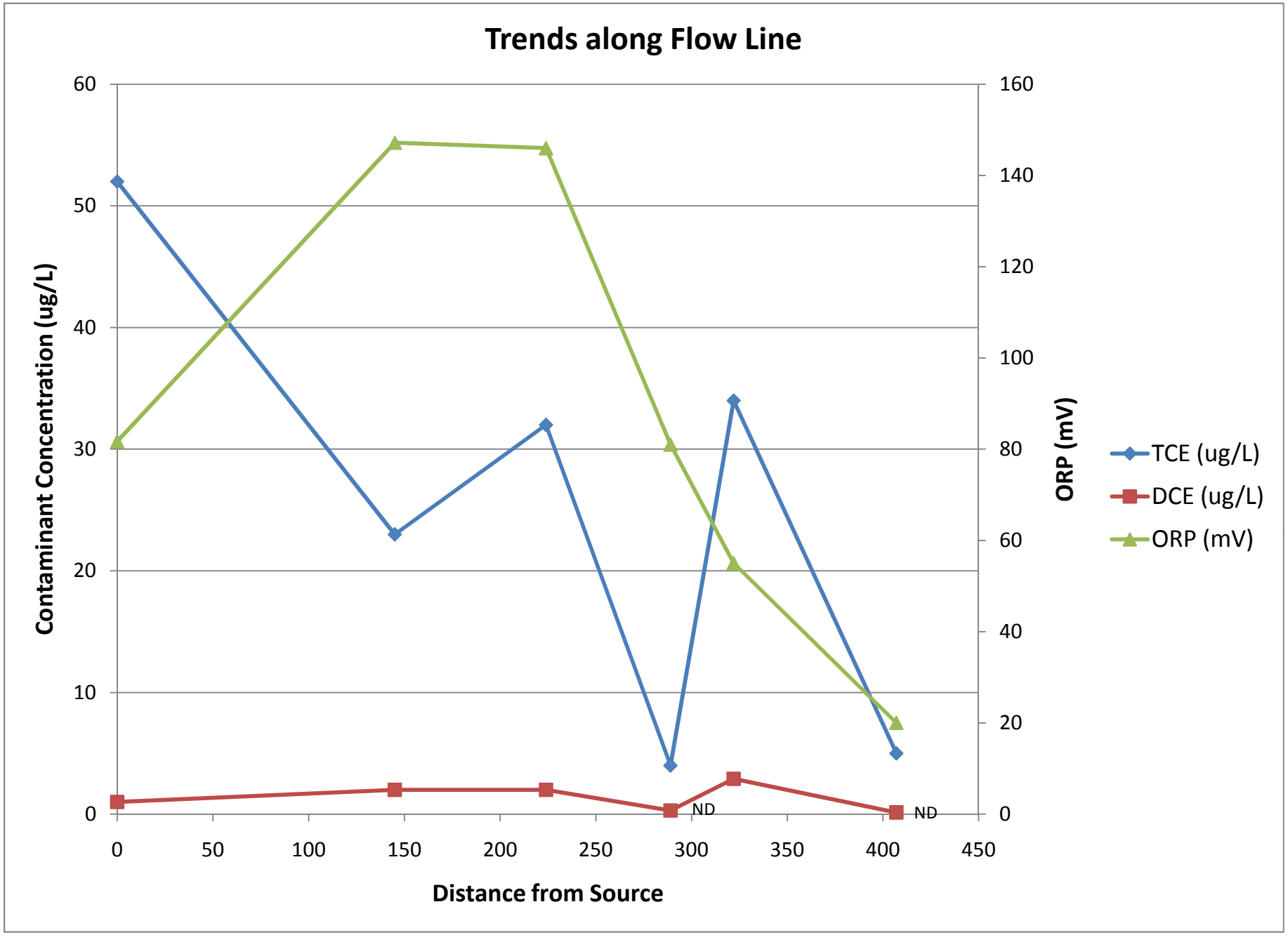
FIGURE 10-9
GEOCHEMICAL OXIDATION AND REDUCTION CONDITIONS



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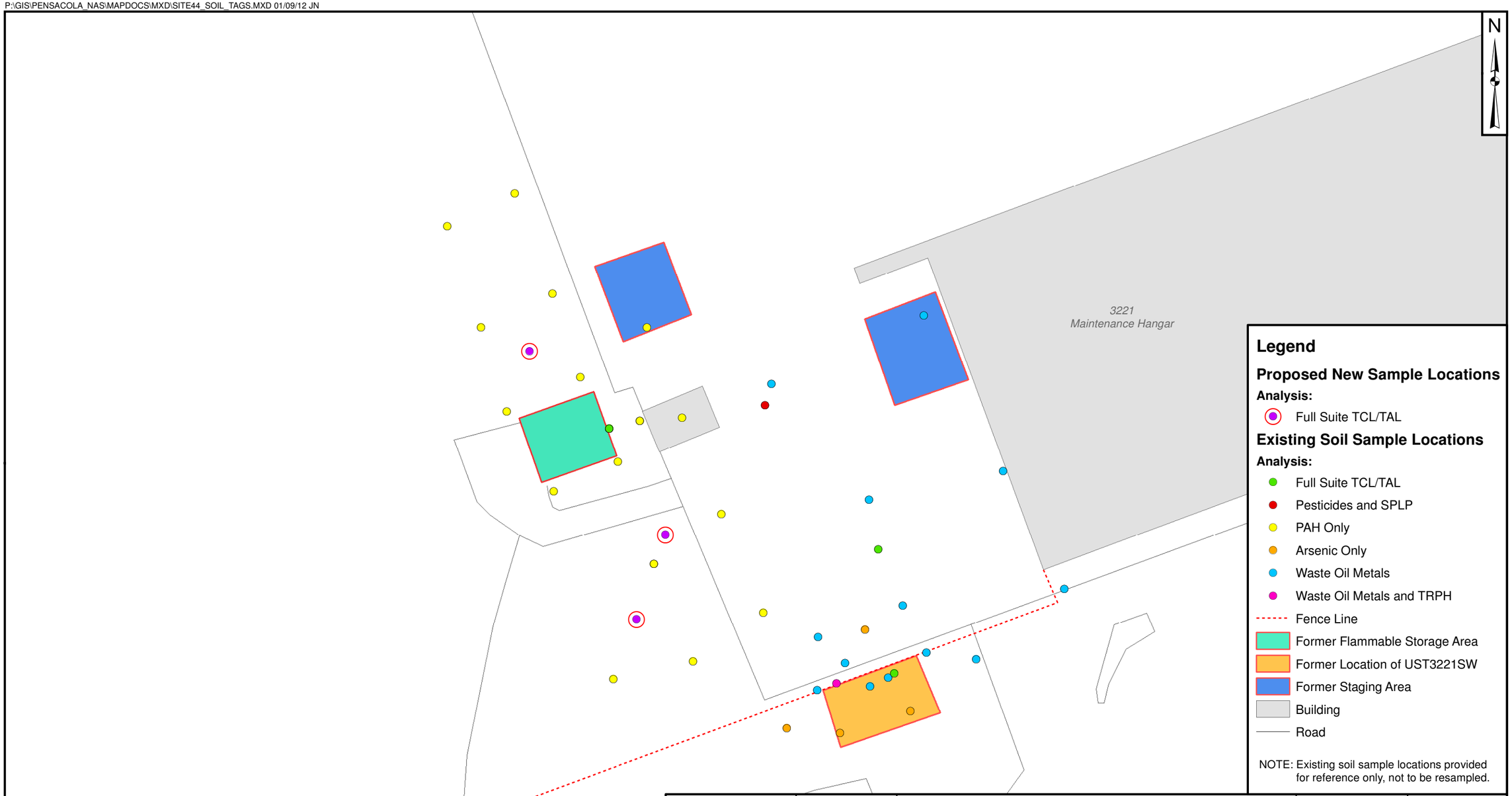

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SOIL SAMPLE LOCATIONS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
	0079
APPROVED BY	DATE
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FIGURE NO.	REV
FIGURE 17-1	0

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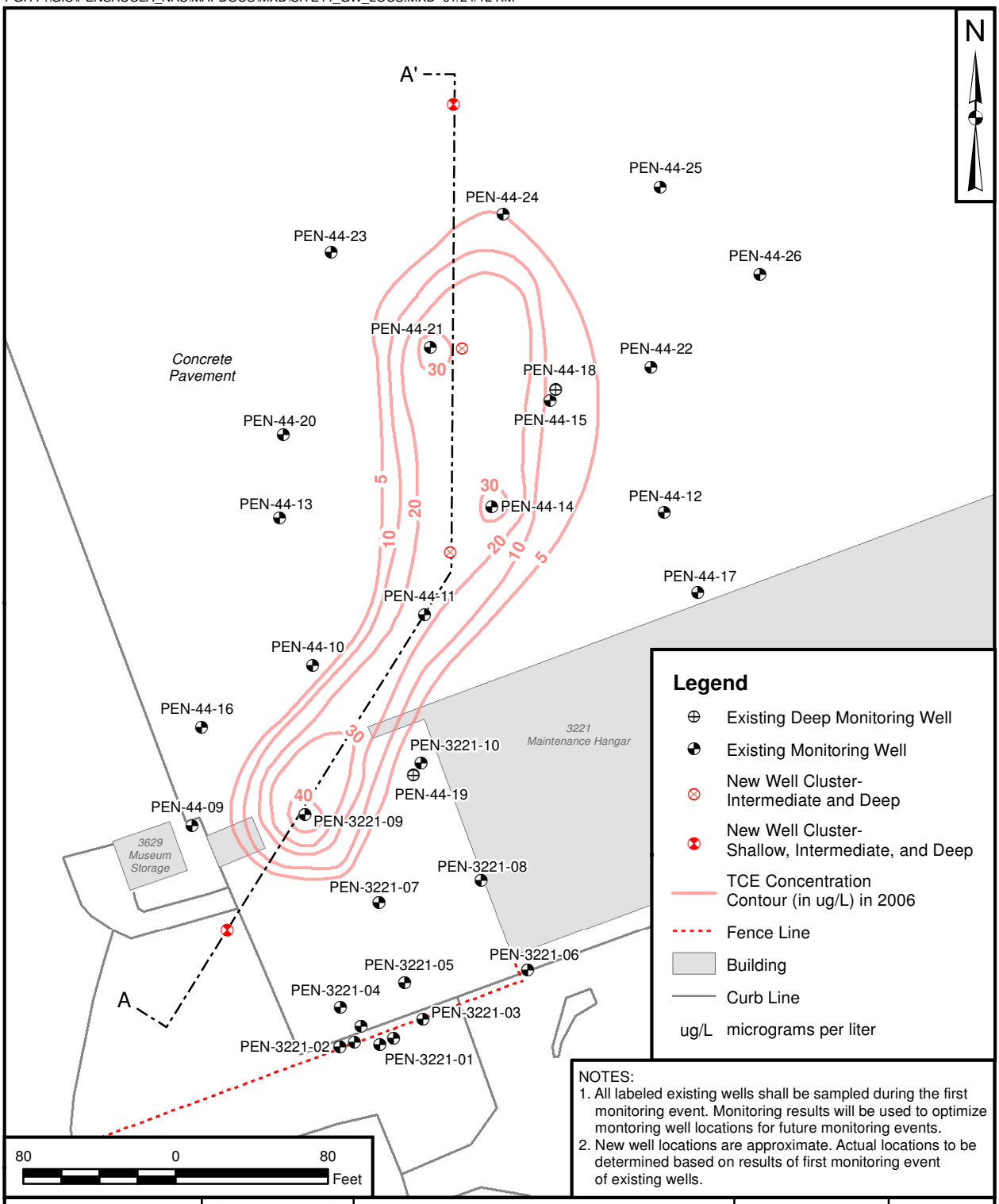

NOTES:
1. All labeled existing wells shall be sampled during the first monitoring event. Monitoring results will be used to optimize montoring well locations for future monitoring events.
2. New well locations are approximate. Actual locations to be determined based on results of first monitoring event of existing wells.

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REVISED BY K. MOORE	DATE 01/24/12		APPROVED BY ___ / DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 17-2 / REV 0

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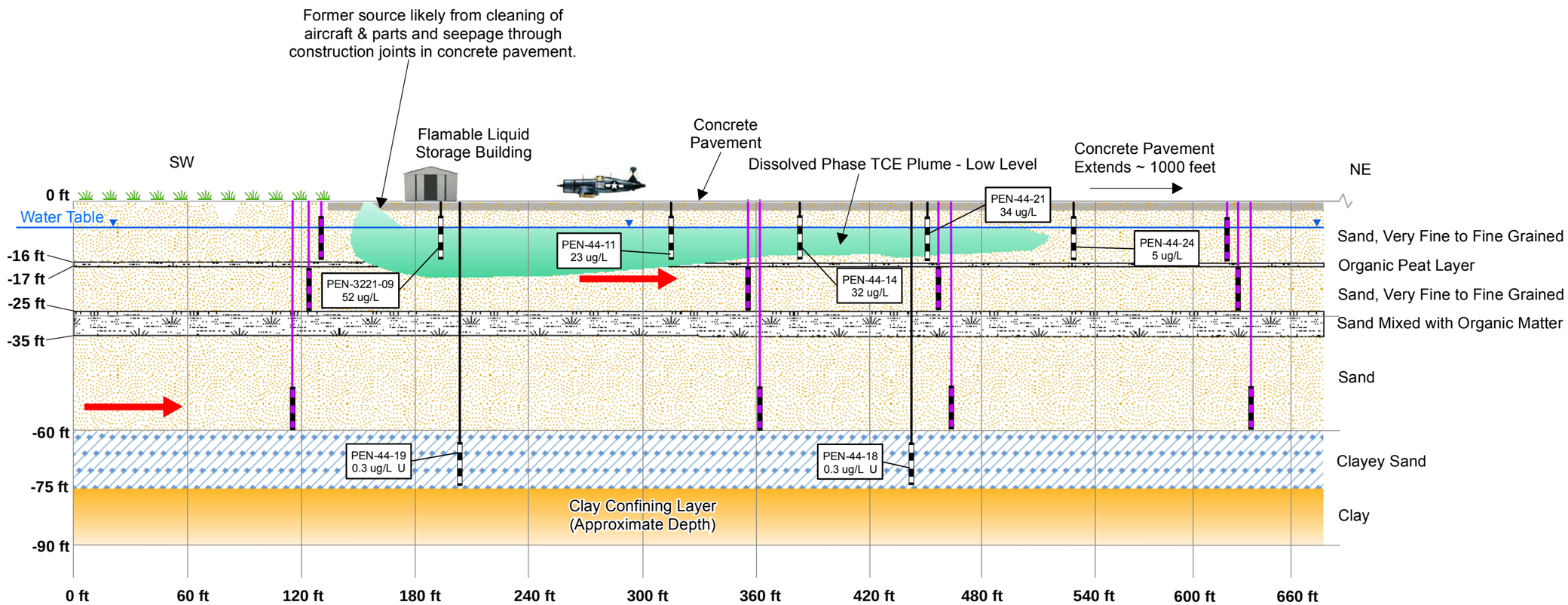

NOTES:
1. USEPA MCL for Trichloroethene is 5 ug/L; Florida MCL is 3 ug/L.
2. See Figure 17-2, for location of Cross Section A-A' and note related to new well locations.
3. ug/L = micrograms per liter
4. U = compound not detected

Legend

- Groundwater Flow Direction
- Monitoring Well
- Existing Monitoring Well Screen Interval
- New Monitoring Well
- New Monitoring Well Screen Interval

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CROSS SECTION A-A'
TRICHLOROETHENE CONCENTRATIONS IN 2005-2006
AND NEW WELL LOCATIONS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
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FIGURE NO. FIGURE 17-3	REV 0

APPENDIX A

SUMMARY OF PREVIOUS INVESTIGATIONS

APPENDIX A1

A1.0 UST Removal and Contamination Assessment Report

The following text provides a summary of the information provided in the Contamination Assessment Report (CAR) on the underground storage tank (UST) removal activities, and the sampling activities and results for the CAR.

A1.1 UST Removal

Site 44 was first investigated as UST Site 3221 SW in 1992, following the removal of a 1,000-gallon UST located at the southwest corner of Building 3221 (Figure 2-3). The former tank had been installed in 1967 and was reportedly used to store PD-680 (a petroleum distillate cleaning solvent). The UST was removed during the NAS Pensacola tank removal program conducted in 1989-1990 and replaced with a new 500-gallon UST used to store waste oil (ABB-ES, 1993). The new 500-gallon UST likely stored waste oil generated from aircraft maintenance operations historically performed at Building 3221. This second UST was removed on May 2, 1994 (Navy, 1994). There are no USTs remaining at the site.

During the initial tank removal activities (which occurred between 1989 and 1990), two soil samples were collected at a depth of approximately 6 feet from the excavation, composited and submitted for analysis of Total Recoverable Petroleum Hydrocarbons (TRPH). TRPH was detected at a concentration of 57 parts per million (ppm) which was slightly above the state screening level for TRPH of 50 ppm in effect at that time.

Based on the TRPH analytical results, the Site required further investigation under Florida petroleum regulations in effect at that time per Chapter 17-770, Florida Administrative Code (F.A.C.).

A1.2 Contamination Assessment Report

In 1992, additional investigations were conducted for a CAR that was prepared as part of the UST investigation (ABB-ES, 1993). The additional investigation consisted of 17 soil borings, 4 temporary monitoring wells, 10 permanent monitoring wells, and 3 groundwater sampling events in January, April, and August 1992 to assess the extent of contamination at the Site (Figure 4-1).

A1.2.1 Soil Assessment

Discreet soil samples were collected at 5 to 7 feet below land surface (bls) at 13 of the soil boring locations and at 2-foot intervals to a depth of 6 feet bls at four boring locations. The soil samples were field screened for organic vapors by the headspace method with a flame ionizing detector (FID). Thirteen

subsurface soil samples were analyzed for waste oil group metals (arsenic, cadmium, chromium and lead) and one subsurface soil sample was analyzed for TRPH.

Based on the OVA FID results of the soil samples collected from the 13 soil boring, volatile organic vapors ranged from 0 to 1 ppm indicating that that petroleum related constituents were minimal. Petroleum odors and staining were not noted to occur in the soil samples. However, a slight sulfur odor was noted at soil boring locations SB10 (PEN-3221SW-MW7) and SB-11 (PEN-3221SW-MW8. SB-10 was located approximately 65 feet north of the former UST and SB-11 was located approximately 90 feet northeast of the former UST and adjacent to Building 3221.

A soil sample collected at a depth of 6 feet bls approximately 4 feet north of the former UST locations contained TRPH at 11 ppm, which was slightly above the Florida criteria of 10 ppm in effect at that time (Figure 5-4). Another soil sample collected at a depth of 6 feet bls approximately 15 feet east of the former UST locations contained lead at 13 ppm, which was below the Florida criteria of 77 ppm in effect at that time.

A1.2.3 Groundwater Assessment

The piezometers and monitoring wells were installed with 10-foot long well screens; and the piezometers were installed to depths of 17 to 20 feet bls and monitoring wells to depths of 14 to 15 foot bls. One piezometer PEN-3221SW-PZ1 was converted to a permanent monitoring well PEN-3221SW-MW2. The monitoring wells were installed and sampled during three separate events in a phased approach to delineate the extent of the plume. Groundwater samples were collected in January, April, and August 1992 from the piezometers and monitoring wells using bailers in accordance with the Florida Department of Environmental Regulation (FDER) (now known as Florida Department of Environmental Protection [FDEP]) approved Comprehensive Quality Assurance Plan.

During each groundwater sampling event, the groundwater samples were analyzed for volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (USEPA) Method 624, semivolatile organic compounds (SVOCs) by USEPA Method 625, total metals (arsenic, cadmium, chromium and lead), and TRPH.

Groundwater level measurements indicated that shallow groundwater at Site 44 flows from southwest to northeast (Figures 5-2 and 5-3).

January 1992 Groundwater Sampling Event

Chloroform, dibromochloromethane, acetone, were detected in the January 1992 groundwater samples at concentrations below their State standard in effect at that time.

Toluene was detected at 16 micrograms per Liter (µg/L) in samples collected from monitoring wells PEN-3221SW-PZ2 and PEN3221SW-PZ3. The detected concentration of toluene was below state standard of 50 µg/L for total VOAs (the sum of benzene, toluene, ethylbenzene, and xylenes) in effect at that time. Toluene was also detected in the trip blank associated with this sampling event at a concentration of 3 µg/L. The analytical laboratory, Wadsworth/ALERT Laboratories, reported a random appearance of toluene in samples, trip blanks, and equipment blanks at levels ranging from 2 µg/L to 22 µg/L. During their investigation of the random contamination, it was discovered that the sample container labels in use at that time were contaminated with toluene and 2-butanone. These compounds are volatile and it is possible that the labels might have contaminated the samples. Because the trip blank associated with this sampling event was contaminated with toluene, and toluene was not reported in later sampling events, the source of the toluene contamination may have been the sample container labels.

Methylene chloride was detected in each of the groundwater samples at concentrations ranging from 12 to 79 µg/L, as well as the trip blank, equipment blank, and laboratory blank at concentrations ranging from 8 µg/L to 14 µg/L. Because methylene chloride is a common laboratory contaminant and was present in the blanks associated with the sampling event, its presence in the samples was attributed to laboratory contamination.

PCE was detected at concentrations above the Florida CTL of 3 µg/L in groundwater samples collected from temporary wells PEN-3221SW-PZ2 (15 µg/L) and PEN-3221SW-PZ3 (9 µg/L) (Figure 5-5). PCE was not detected in the samples collected from monitoring well PEN-3221SW-MW1 and temporary well PEN-3221SW-PZ1 (renamed as permanent monitoring well PEN-3221SW-MW2).

April 1992 Groundwater Sampling Event

Lead was detected only in the duplicate sample collected from monitoring well PEN-3221SW-MW1 at a concentration of 6 µg/L, below the Florida CTL of 50 µg/L for lead (Figure 5-6). Chloroform was detected in samples from only one well, PEN-3221SW-MW3, at a concentration of 1 µg/L. This concentration is well below the Florida CTL of 100 µg/L.

Methylene chloride was detected in the groundwater sample from monitoring well PEN-3221SW-MW5 and the laboratory blank at concentrations of 13 µg/L and 1 µg/L, respectively (Figure 5-6). Because methylene chloride is a common laboratory contaminant and was present in the blanks associated with the sampling event, its presence in the samples was attributed to laboratory contamination.

PCE was detected in the groundwater samples collected from monitoring wells PEN-3221SW-MW3 (8 µg/L), PEN-3221SW-MW4 (1 µg/L), and PEN-3221SW-MW5 (6 µg/L) (Figure 5-6). PCE was the only contaminant detected at concentrations that exceeded Florida CTLs in effect at that time.

Seventeen tentatively identified compounds (TICs) were detected in the groundwater sample collected from monitoring well PEN-3221SW-MW5. These compounds were considered to be breakdown products of fuel. Butylcyclobutane was tentatively identified in the groundwater samples from monitoring wells PEN-3221SW-MW1 and PEN-3221SW-MW4. Butylcyclobutane is a possible breakdown product of fuel.

Because of the low concentrations of PCE detected in the January and April 1992 groundwater sampling events, the site investigation was allowed by the FDER to continue in accordance with Florida regulations [Chapter 17-770, Florida Administrative Code (F.A.C.)] for the petroleum program in effect at that time. The investigation at Site 3221SW resumed with the August 1992 groundwater sampling event.

August 1992 Groundwater Sampling Event

Methylene chloride was detected (concentrations ranged from 3 to 11 µg/L) in every sample, as well as the laboratory, trip, and equipment blanks. Because methylene chloride is a common laboratory contaminant and was present in the blanks associated with the sampling event, its presence in the samples was attributed to laboratory contamination.

Bis(2-ethylhexyl)phthalate was detected (10 µg/L) in the groundwater sample from monitoring well PEN-3221SW-MW8 at a concentration below the Florida CTL of 14 µg/L (Figure 5-7). Bis(2-ethylhexyl)phthalate is a plasticizer, and its presence was considered to be the result of contamination from the plastic gloves used during sample collection.

PCE and TCE were both detected at or exceeding the Florida CTL of 3 µg/L in effect at that time (Figure 5-7). PCE was detected in the groundwater sample collected from monitoring well PEN-3221SW-MW8 at a concentration of 3 µg/L. TCE was detected in groundwater samples collected from monitoring wells PEN-3221SW-MW7 (4 µg/L), PEN-3221SW-MW9 (5 µg/L), and PEN-322lSW-MW10 (25 µg/L). At the time of the August 1992 sampling event, monitoring well PEN-3221SW-MW8 (approximately 100 feet

northeast from the location of the former UST) was the most hydraulic downgradient monitoring well at the site with a detection of PCE, and monitoring well PEN-3221SW-MW10 (approximately 120 feet northeast from the location of the former UST) was the most hydraulic downgradient monitoring well at the site with a detection of TCE.

Eighteen TICs were detected in the groundwater samples collected from monitoring wells PEN3221SW-MW4, PEN-3221SW-MW5, PEN-3221SW-MW6, PEN-3221SW-MW8, and PEN-3221SW-MW10. These compounds were considered to be primarily fuel breakdown products.

A1.2.4 Summary of the CAR Findings

The source of chlorinated solvents in groundwater was not determined during the UST investigation, but was speculated to be associated with the former Building 3629, the flammable storage area located west of Building 3221 (Figure 5-8). Soil samples were not analyzed for chlorinated solvents during the investigation; therefore a definitive statement was not made in the 1993 CAR regarding impacts by chlorinated solvents to that media. The TICs identified during the April and August 1992 sampling events are potential breakdown products of fuel, therefore, the former UST was considered to be a possible source of these contaminants.

A1.2.5 Supplemental Assessment Activities

Upon review of the CAR, FDEP requested that a supplemental assessment be completed around the UST. An additional temporary monitoring well was installed at the former location of the UST to determine if the old tank was the source of TICs (Figure 3-1). The groundwater sample was analyzed for VOCs by USEPA Method 624, SVOCs by USEPA Method 625, total metals (arsenic, cadmium, chromium and lead) and TRPH.

The supplemental assessment activities were conducted in May 1994 and included: UST removal, OVA headspace monitoring of soils during UST removal, installation of the temporary monitoring well and groundwater sampling and groundwater flow determination. The assessment results indicated:

- The UST was removed and petroleum contaminated soils were not identified.
- Groundwater flow was from the southwest toward the northeast (Figure 3-2).
- No petroleum related constituents, TICs or TRPH was detected.

- Cadmium, chromium and lead were detected in the groundwater sample from temporary Monitoring Well TW-1.
- Only lead was detected at a concentration (18 µg/L) exceeding Florida regulatory standard of 15 ppb. The groundwater sample was turbid and unfiltered.

Because of the detection of chlorinated solvents in groundwater, the Navy transferred this site to the Installation Restoration (IR) Program for further assessment. Site soil and groundwater did not exceed state petroleum program guideline concentrations for petroleum related constituents; therefore, the site received No Further Action (NFA) for these constituents.

APPENDIX A1 FIGURES

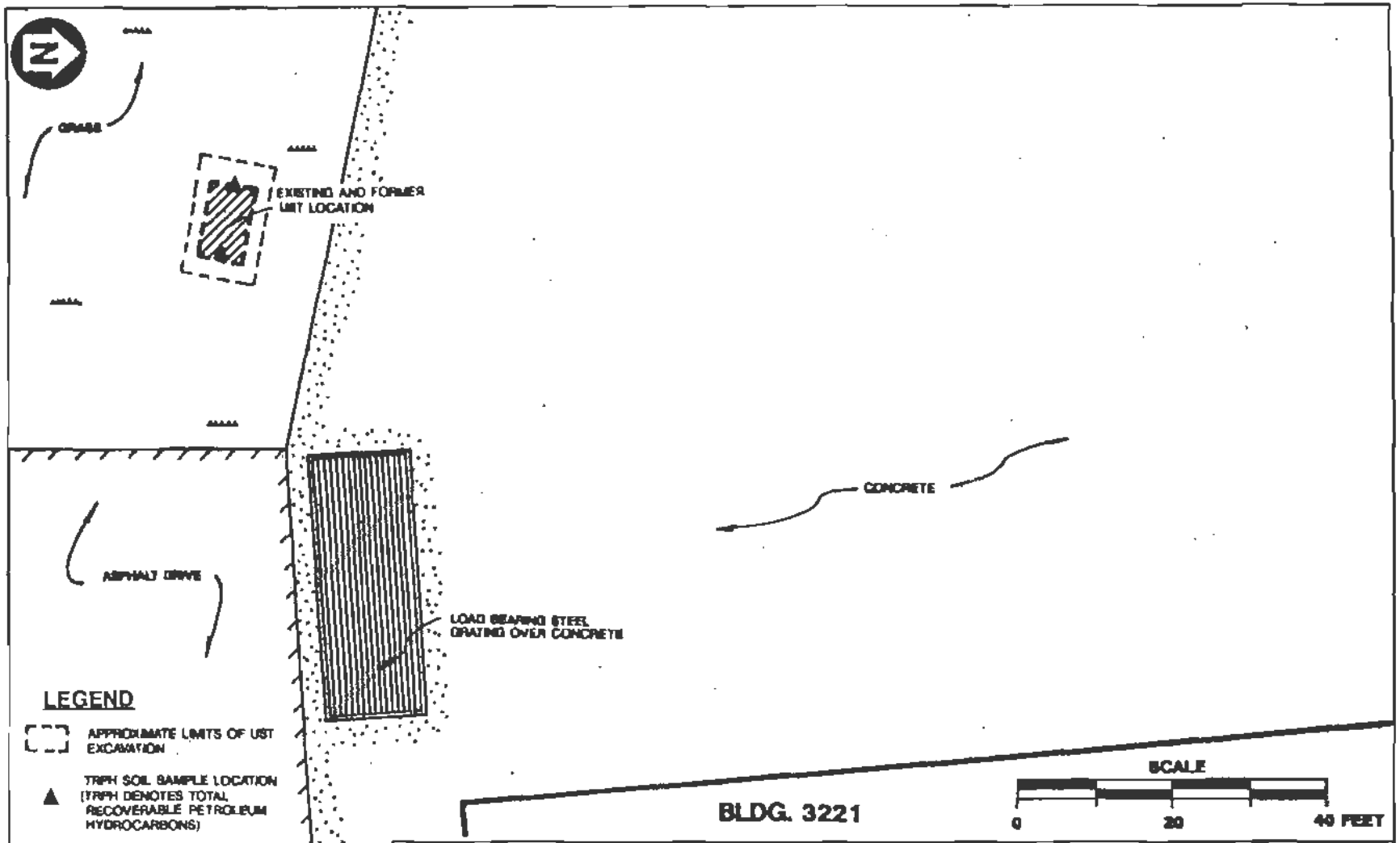


FIGURE 2-3
APPROXIMATE EXCAVATION LIMITS
AND TRPH SOIL SAMPLE LOCATIONS

CONTAMINATION
ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA

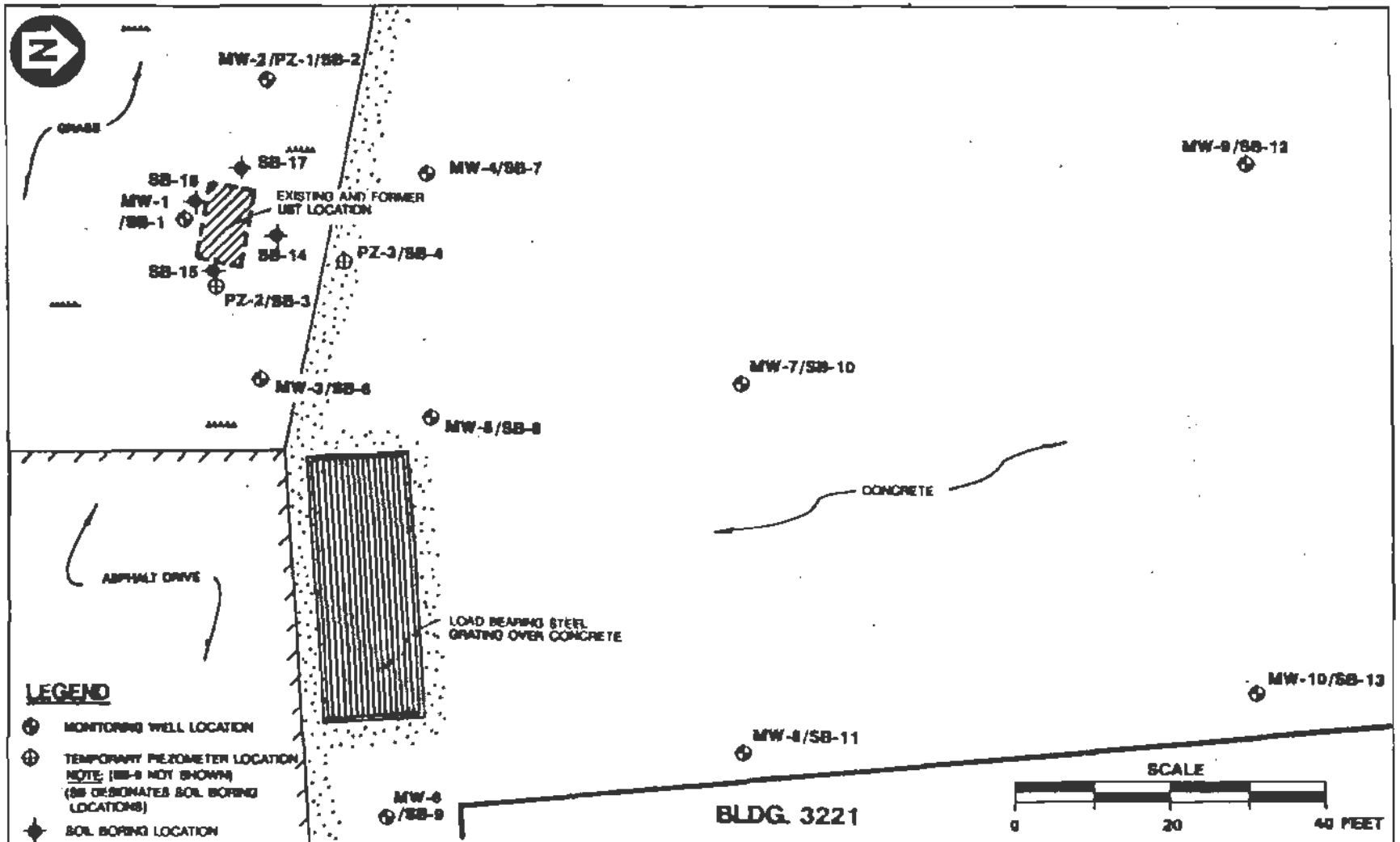


FIGURE 4-1
SOIL BORING AND
MONITORING WELL LOCATIONS

CONTAMINATION
ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA

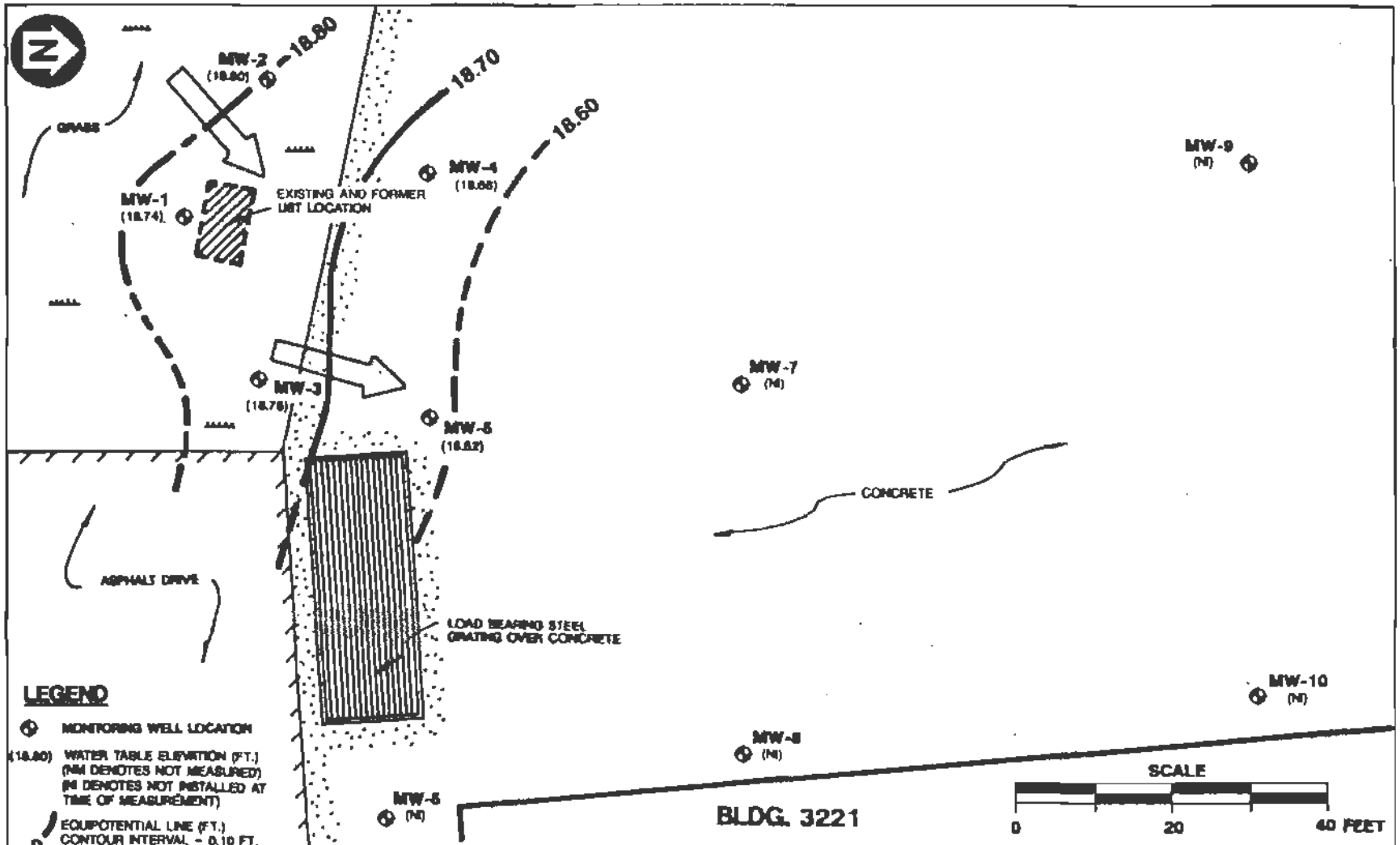


FIGURE 5-2
WATER TABLE ELEVATION CONTOUR MAP,
SURFICIAL ZONE,
SAND-AND-GRAVEL AQUIFER,
MAY 20, 1992

CONTAMINATION
ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA

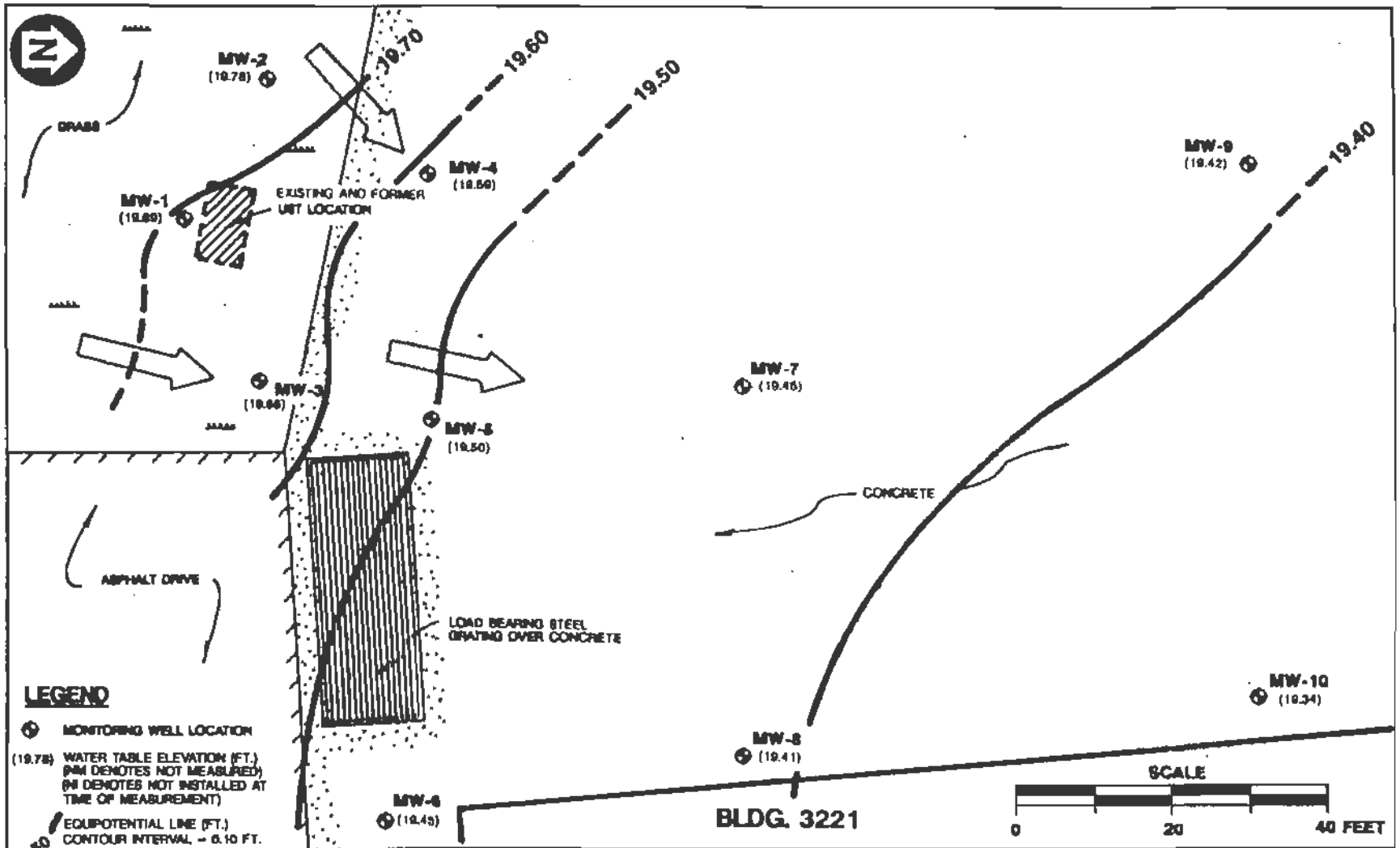


FIGURE 5-3
WATER TABLE ELEVATION CONTOUR MAP,
SURFICIAL ZONE,
SAND-AND-GRAVEL AQUIFER,
AUGUST 29, 1992

CONTAMINATION
ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA

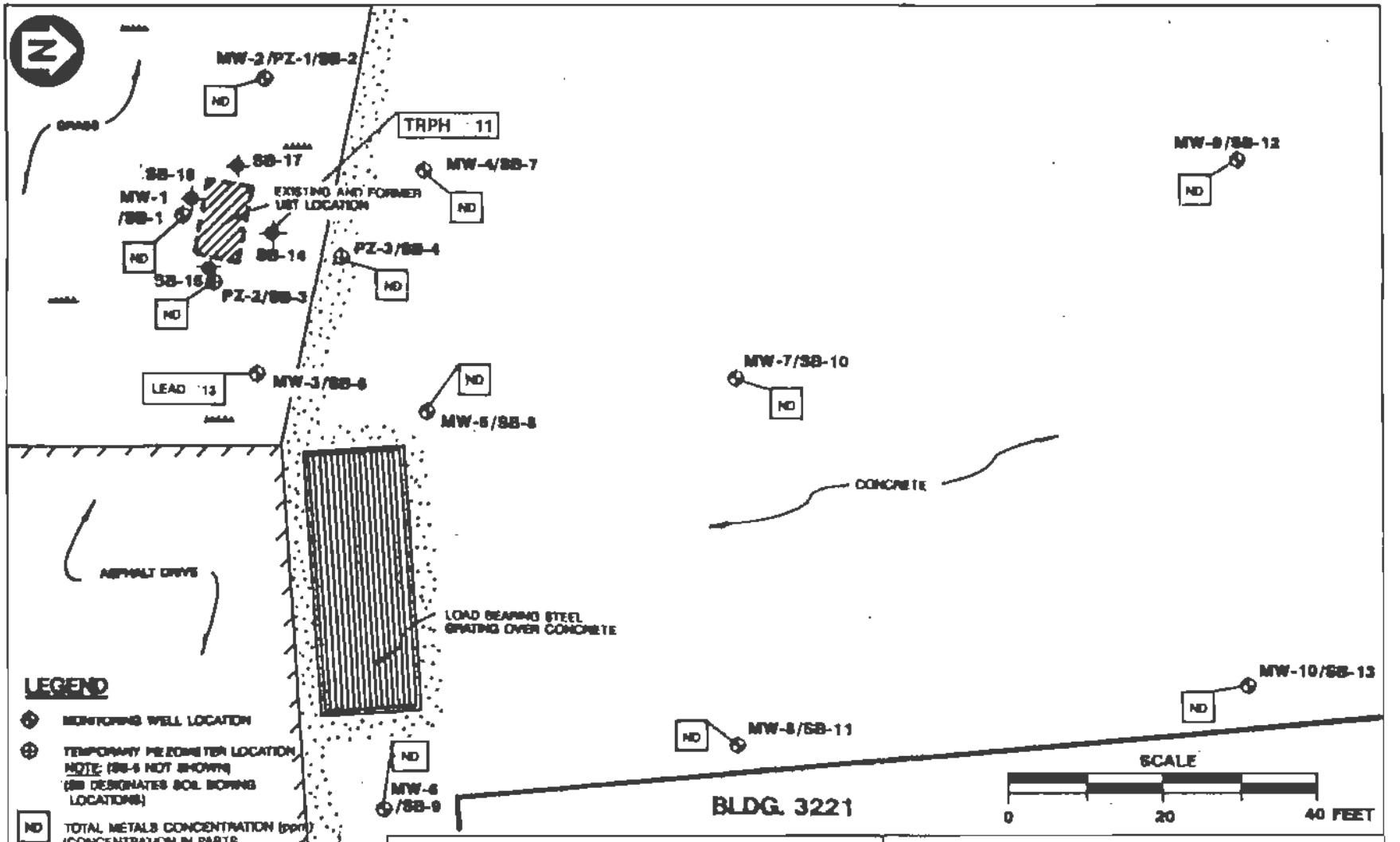


FIGURE 5-4
SOIL CONTAMINATION DISTRIBUTION MAP,
JANUARY THROUGH DECEMBER 1992

CONTAMINATION
ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA

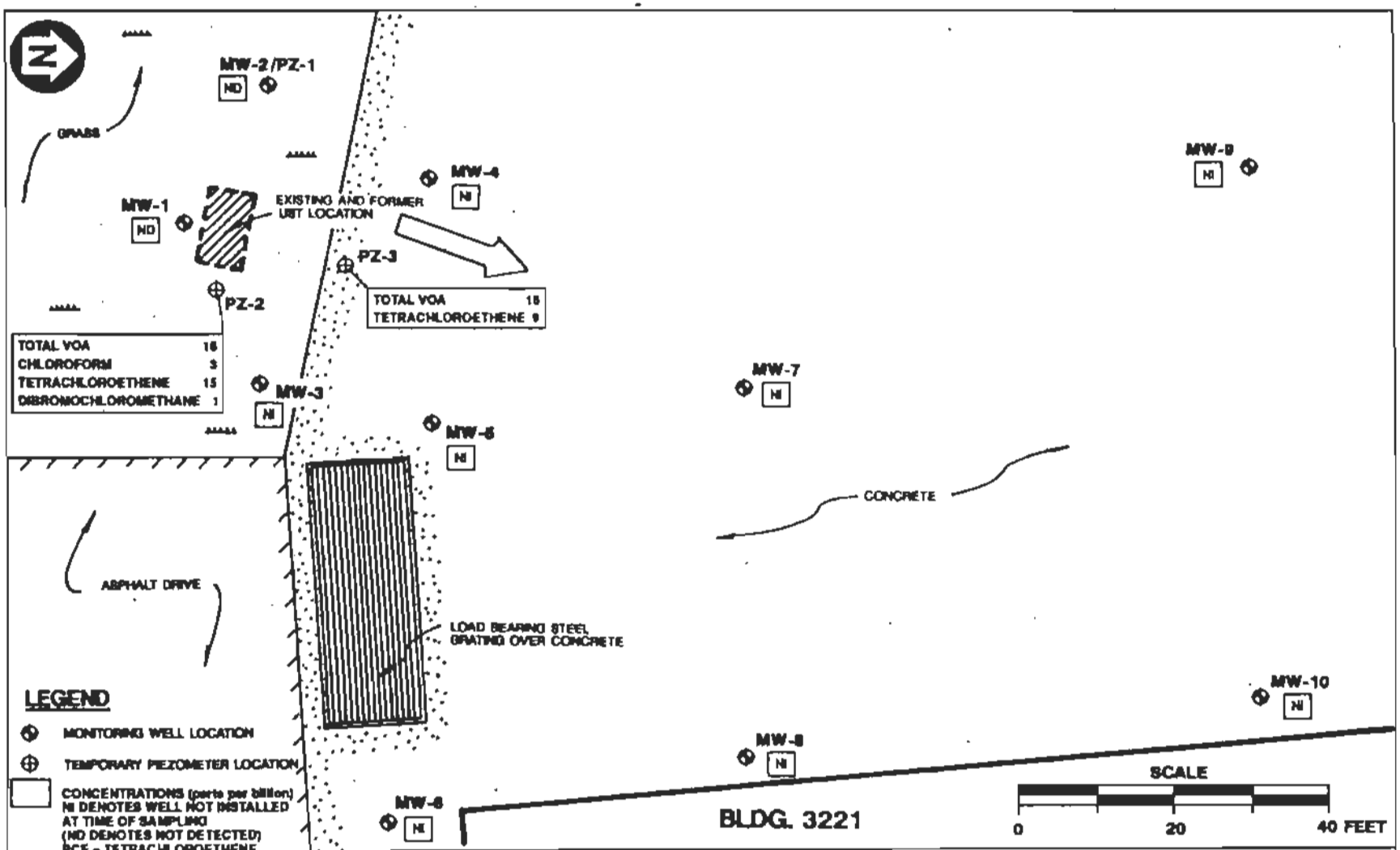


FIGURE 5-5

GROUNDWATER CONTAMINATION DISTRIBUTION MAP, JANUARY 25, 1992

CONTAMINATION ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA

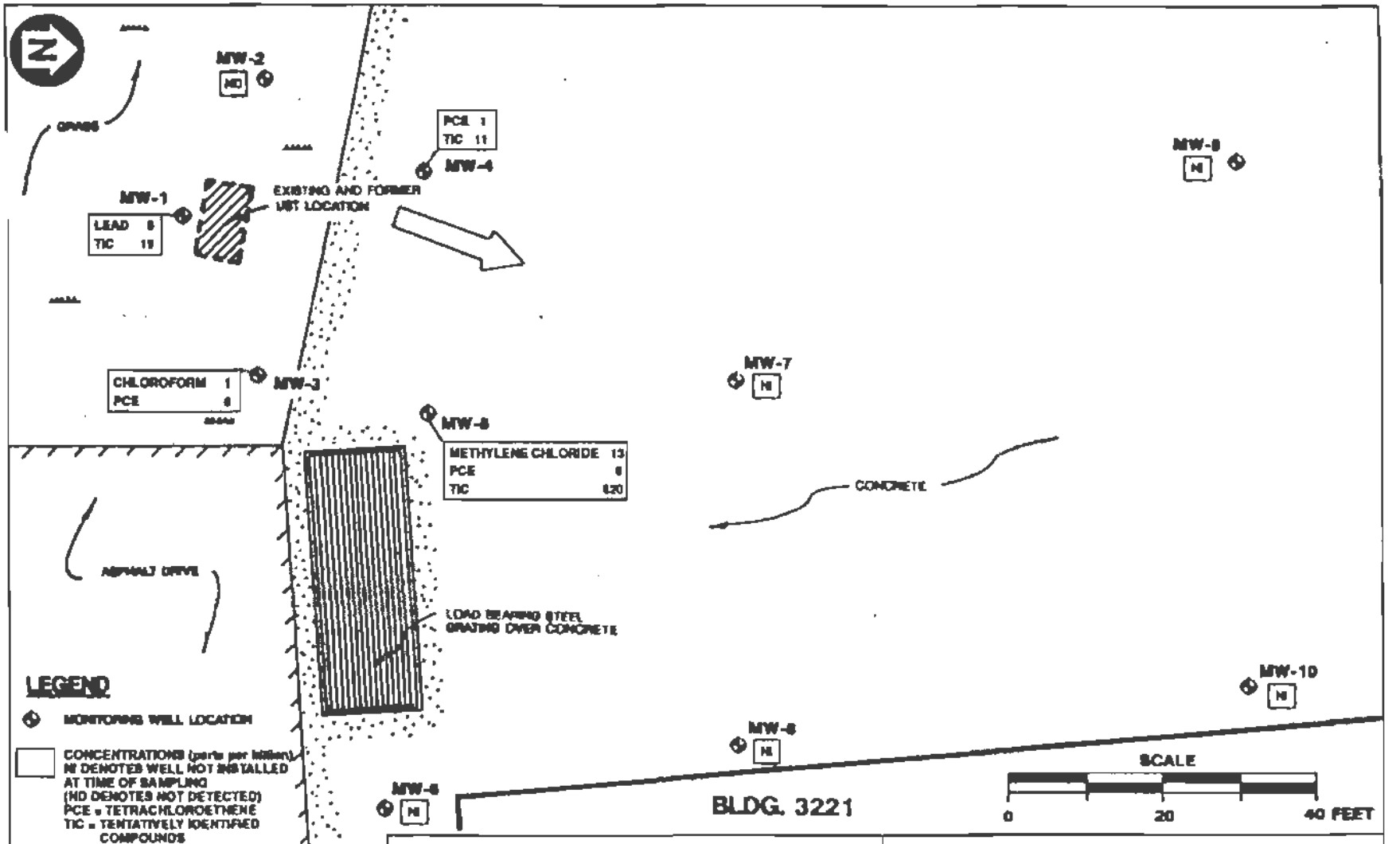


FIGURE 5-6

GROUNDWATER CONTAMINATION DISTRIBUTION MAP, APRIL 15, 1992

CONTAMINATION ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA

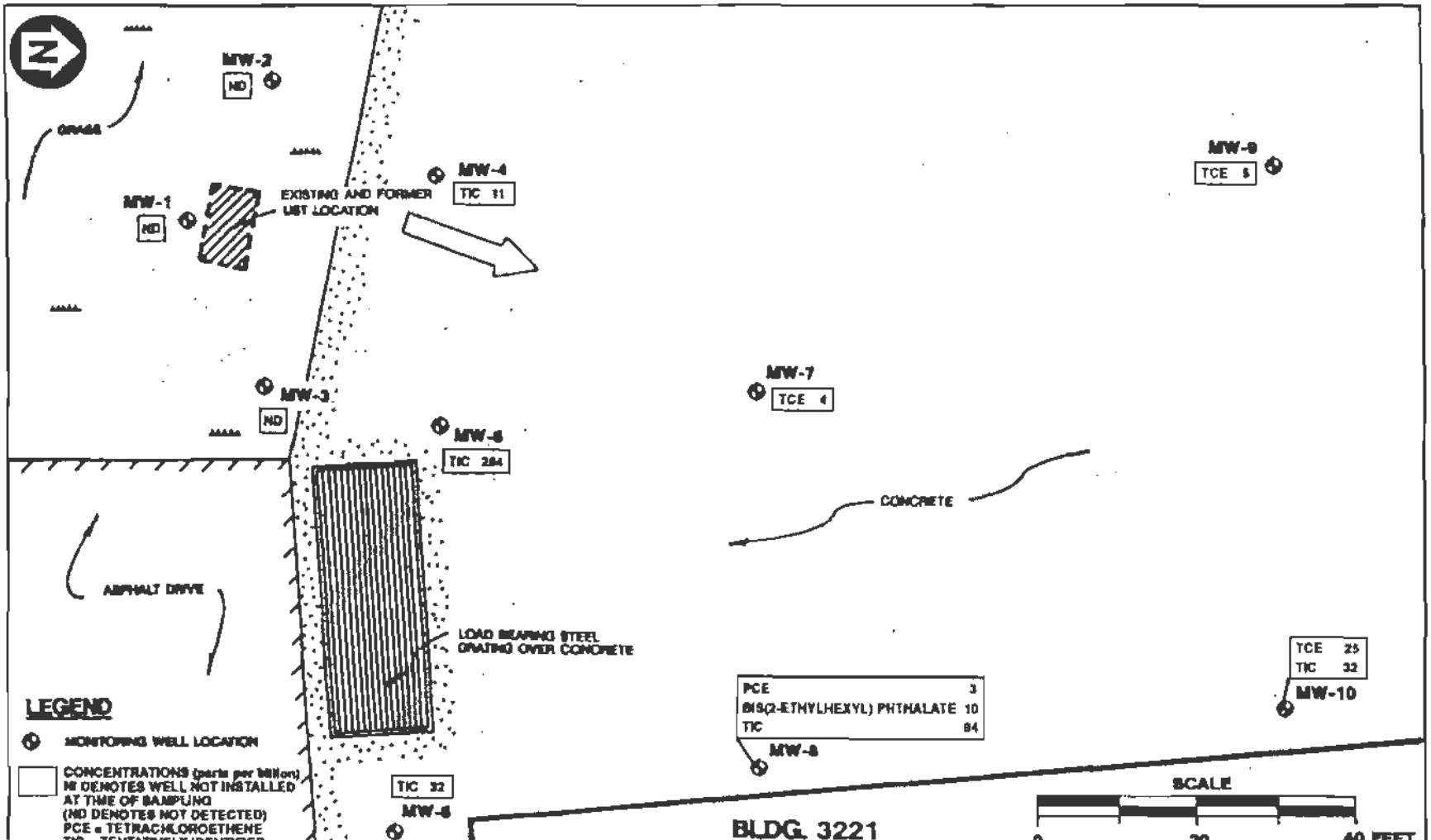


FIGURE 5-7

GROUNDWATER CONTAMINATION
DISTRIBUTION MAP,
AUGUST 29, 1992

CONTAMINATION
ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA

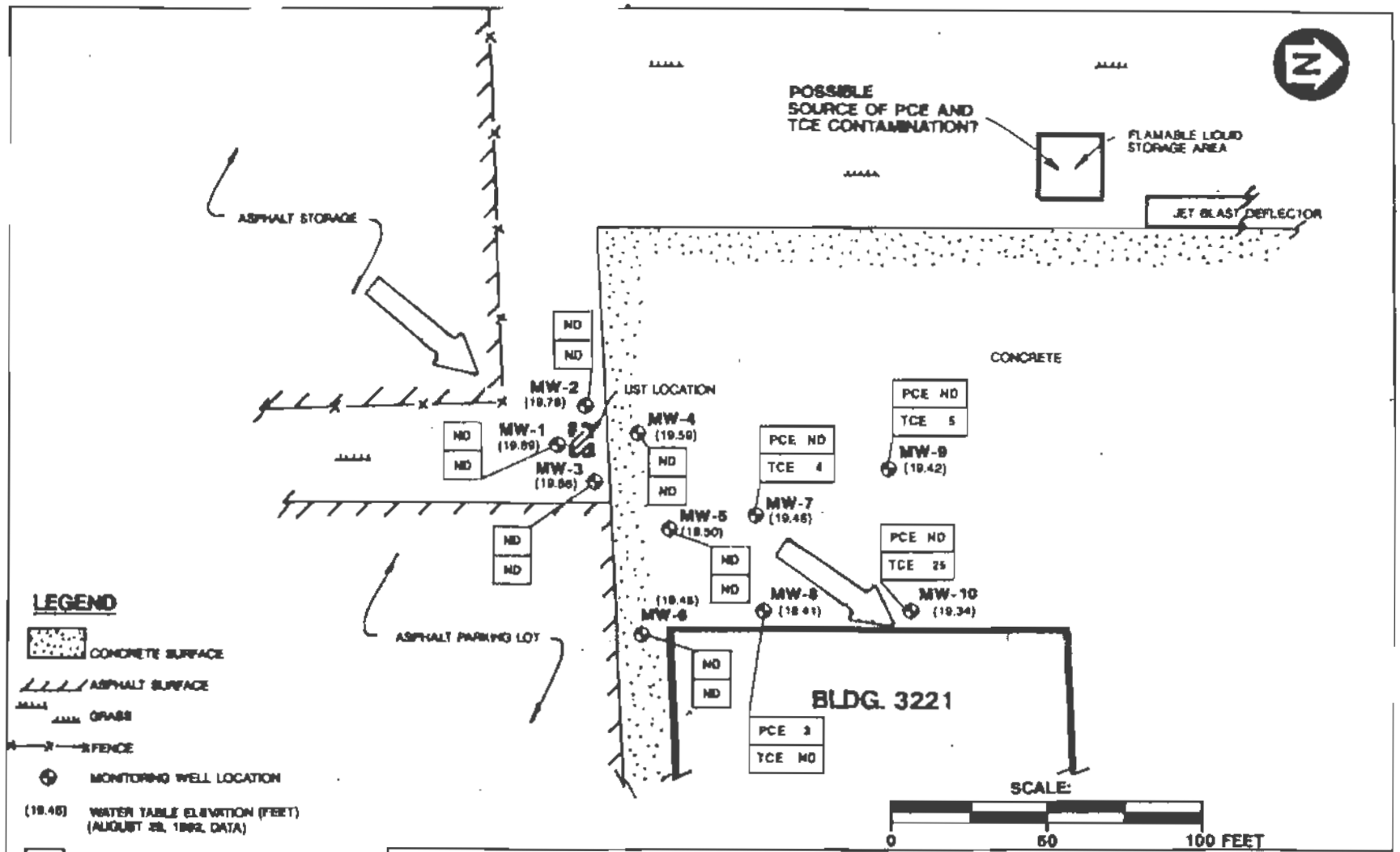
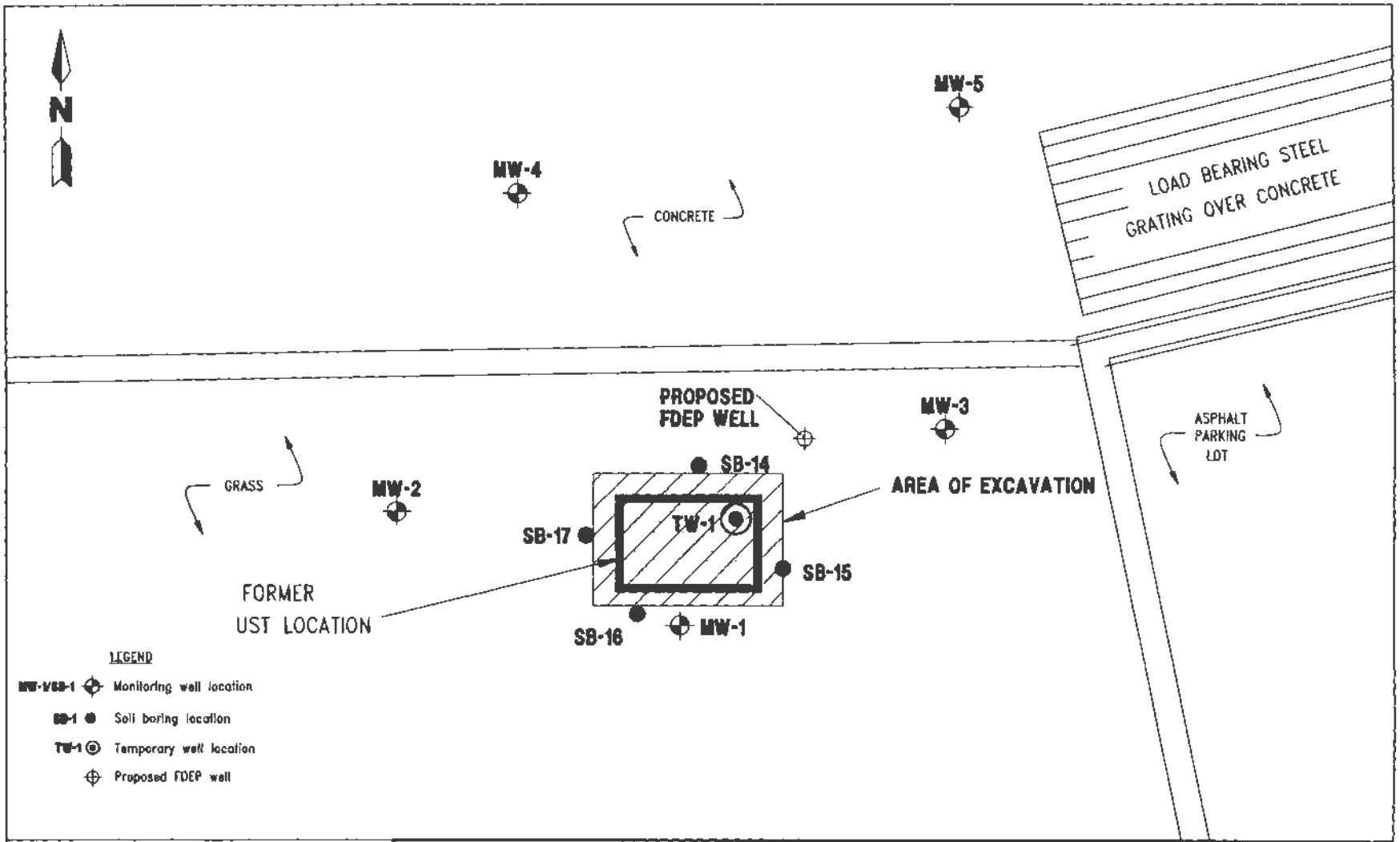


FIGURE 5-8
TCE AND PCE CONTAMINATION DISTRIBUTION AND GROUNDWATER FLOW DIRECTION MAP, AUGUST 29, 1992

CONTAMINATION ASSESSMENT REPORT
SITE 3221SW
NADEP PENSACOLA
PENSACOLA, FLORIDA



0 05 10

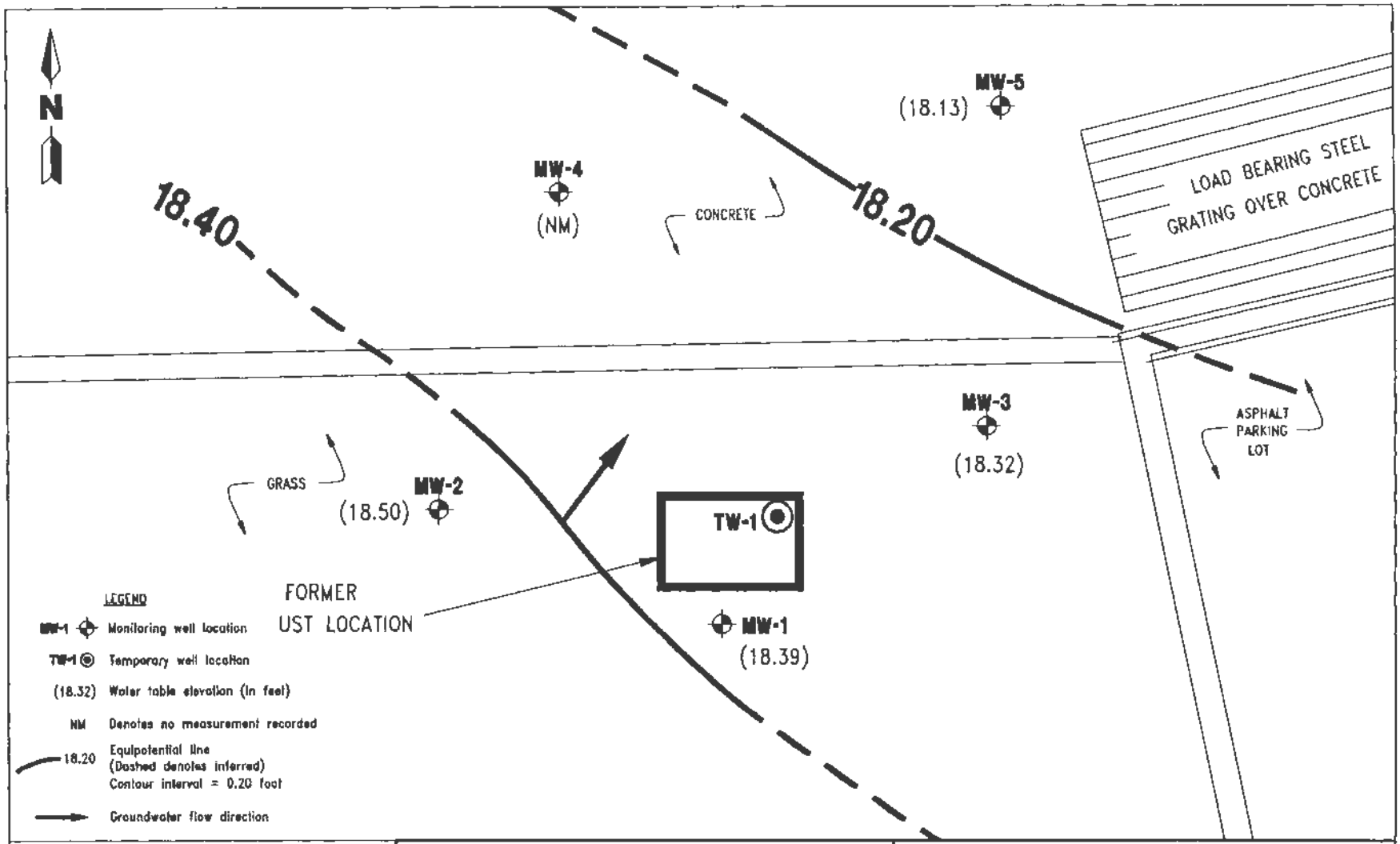
SCALE: 1" = 10'

PENSCOLA\3221\WDW\07-14-94

FIGURE 3-1
AREA OF EXCAVATION AND TEMPORARY WELL TW-1 LOCATION, UST CLOSURE ACTIVITIES

CONTAMINATION ASSESSMENT REPORT ADDENDUM
SITE 3221SW

NADEP PENSACOLA
PENSACOLA, FLORIDA



0 05 10

SCALE: 1" = 10'

PENSCOLA\3221\WDW\07-13-94

FIGURE 3-2
WATER TABLE ELEVATION CONTOUR MAP, JULY 6, 1994

CONTAMINATION ASSESSMENT REPORT ADDENDUM
SITE 3221SW

NADEP PENSACOLA
PENSACOLA, FLORIDA

Appendix A2

A2.0 Remedial Investigation Report

Because a release of contaminants at Site 44 appears to have resulted from routine aircraft maintenance operations a Remedial Investigation (RI) was performed from 2005 through 2006. The time of disposal or accidental release(s) is unknown. The RI was conducted to delineate the nature and extent of soil and groundwater contamination at potential source areas at Site 44 and to characterize risks to human health and the environment (Tetra Tech, 2008).

Field activities for the RI consisted of collecting soil samples for on-site laboratory analysis (Figure 2-1). The results of the soil samples were used to provide a preliminary evaluation of site conditions at potential source areas and to select locations for soil samples that would be analyzed by an off-site laboratory for analytes in the USEPA Target Compound List (TCL) and Target Analyte List (TAL) and TRPH.

The results of the soil field screening and off-site laboratory soil samples were also used to select locations for additional monitoring wells (Figure 2-2). Groundwater samples from existing and newly installed monitoring wells were analyzed by an off-site laboratory for the full TCL/TAL analyte list and TRPH.

During the RI, water levels were measured at Site 44 during 4 events, January 12, 2005 (Figure 3-2), January 20, 2005 (Figure 3-3), May 12, 2006 (Figure 3-4), and August 14, 2006 (Figure 3-5). Based on the four water level measurement events, the groundwater flow direction was consistently toward the northeast.

A2.1 Soil Investigation

Twenty-nine soil borings were advanced using Direct Push Technology (DPT) to collect soil samples at potential source areas at Site 44. The DPT soil borings were located around the perimeter of the foundation of former Building 3629, which had been used for flammable liquid storage; the former staging area located to the northeast of Building 3629, in a grid pattern at the wash rack (the wash rack is a concrete paved area immediately west of Building 3221) to provide full coverage of the area; at the approximate location of UST 3221 SW; and the southwest side of Building 3221, which included a former materials staging area that was marked on the concrete.

Because the depth to groundwater at the site was approximately 6 feet bls, the soil screening samples were collected from the ground surface to 6 inches bls (if concrete was not present), 6 inches to 2 feet bls, 2 feet to 4 feet bls, and 4 feet to 6 feet bls.

The soil samples collected from the DPT borings were analyzed on-site for a select list of cVOCs and petroleum related compounds by a mobile laboratory. The cVOCs included 1,1- and 1,2-dichloroethane (DCA), 1,1- and 1,2-(cis and trans) dichloroethene (DCE), methylene chloride, 1,1,1- and 1,1,2-trichloroethane (TCA), TCE, and PCE. The petroleum related compounds included benzene, toluene, ethylbenzene, xylenes (BTEX), and naphthalene.

Based on the mobile laboratory analytical results, only one DPT soil boring (44SB11) contained a detectable concentration of a target analyte. PCE was detected at 0.028 milligrams per kilogram (mg/kg) and did not exceed its Florida SCTL (Figure 4-1). The target analytes were not detected in the soil samples collected from the other soil boring locations.

Following the soil screening of the DPT soil samples by the on-site laboratory, additional soil sampling was conducted in September 2005 to further characterize the nature of potential contaminants at the site by submitting soil samples for off-site laboratory analysis. The potential source areas sampled included soil boring 44SB02 at the east side of Building 3629 which had been used for flammable liquid storage, the location of 44SB11 that based on analytical results from the mobile laboratory had a detectable concentration of PCE, and soil boring 44SB25 at the approximate location of UST 3221 SW (Figure 2-1). The soil samples were collected from the ground surface to 6 inches bls, 6 inches to 2 feet bls, and 2 to 4 feet bls.

The soil samples from soil borings 44SB02, 44SB11, and 44SB25 were analyzed for the full USEPA TCL analytes including VOCs, SVOCs, PAHs, Pesticides and PCBs, TAL metals, and TRPH. Additionally, characterization soil samples were collected for Synthetic Precipitation Leaching Procedure (SPLP) extraction and analysis for TCL VOCs and TAL metals.

Based on the laboratory analytical results, only acetone was detected in one of the characterization surface soil samples, 44SB0201, at an estimated concentration of 120 micrograms per kilogram (µg/kg), less than its SCTL (Figure 4-2). Concentrations of other VOCs were less than their method detection limits.

Carcinogenic PAHs (cPAHs) were the only SVOCs detected at concentrations greater than the Florida direct exposure Soil Cleanup Target level (SCTL). The cPAHs were detected in each of the three surface soil samples collected at Site 44, but only exceeded the SCTL at boring location 44SB02 on the east side of the foundation of former Building 3629 (Figure 4-2).

Detected concentrations of pesticides were limited to one soil boring location (44SB0201). Concentrations of these pesticides were less than their Florida direct exposure SCTLs.

TRPH was detected in soil borings 44SB02 and 44SB25 at concentrations less than the SCTL for TRPH. TRPH was less than its method detection limit in soil samples collected at 44SB11.

Eighteen of the TAL metals were detected in the soil samples from soil borings 44SB02, 44SB11 and 44SB25. However, only arsenic exceeded its SCTL at one sample location (44SB25), the former location of former UST 3221SW (Figure 4-2).

Based on the SPLP analytical results, lead and cadmium were detected at concentrations exceeding their Florida CTLs. The total lead concentrations in soil samples collected at Site 44 were less than the NAS Pensacola background value. The total cadmium results for the Site 44 soil samples were less than the default leaching to groundwater SCTL. Based on this assessment, lead and cadmium were not considered to present a threat to groundwater by leaching from the Site 44 soils.

Additional soil borings were conducted to assess the locations where cPAHs (44SB02) and arsenic (44SB25) exceeded their Florida SCTL. Seventeen additional soil borings (44SB31 to 44SB35 and 44SB41 to 44SB52) were advanced around soil boring location 44SB02 and were analyzed only for PAHs. Five additional soil borings (44SB36 to 44SB40) were advanced around the soil boring location 44SB25 and the samples were analyzed only for arsenic.

cPAH delineation sampling identified an area of cPAH exceedances in the vicinity of the foundation for former Building 3629. Four soil boring locations (44SB02, 44SB31, 44SB34, and 44SB47) had benzo(a)pyrene equivalent concentrations exceeding the Florida residential direct exposure SCTL (Figure 4-4).

The arsenic delineation sampling indicated that arsenic exceedances were limited to soil boring location, 44SB25. At this location, arsenic was detected in two soil samples at concentrations greater than the Florida residential direct exposure SCTL. However, these arsenic concentrations were within the

background range determined by statistical analysis for the distribution of arsenic and iron at NAS Pensacola (Figure 4-3).

A2.2 Groundwater Investigation

During previous groundwater sampling events conducted in 1992 at the site, groundwater samples were analyzed for petroleum related constituents required per the Florida UST program. However, based on the reported detection of PCE in the CAR, the groundwater characterization samples collected during the RI were analyzed for the full USEPA TCL analytes including VOCs, SVOCs, PAHs, Pesticides and PCBs, TAL metals, and TRPH. Groundwater analytical results were compared to Florida drinking water criteria per Chapter 62-550, F.A.C. and Florida GCTLs per Chapter 62-777, F.A.C., USEPA Maximum Contaminant Levels (MCLs) and the NAS Pensacola background concentrations for metals.

A network of 10 shallow monitoring wells previously installed at the site (designated as PEN-3221-XX) during the Site 3221 SW UST investigation (1992) and new permanent monitoring wells (designated as PEN-44-XX), including both shallow and deep monitoring wells were included as part of the RI (Figure 2-2). Seven shallow monitoring wells (designated PEN-44-09 to PEN-44-15) were installed during the first phase of the site characterization investigation to an approximate depth of 15 feet below land surface (bls). In addition, two deep permanent monitoring wells (PEN-44-18 and PEN-44-19) were installed to an approximate depth of 75 feet bls. Based on the results of the initial groundwater sampling event, nine additional shallow wells (including PEN-44-16 and PEN-44-17, PEN-44-20 to PEN-44-26) were installed at the site to delineate VOCs detected in groundwater samples.

Groundwater samples were collected from the existing Site 3221 wells and the newly installed monitoring wells to assess the current groundwater conditions. Groundwater samples were collected using a peristaltic pump and low-flow quiescent purging technique. Groundwater sampling was conducted in three sampling events, December 2005, May 2005, and August 2005, in a phased approach to delineate the extent of the plume. Monitoring wells sampled in previous RI sampling events were not resampled in subsequent events.

December 2005 Groundwater Sampling Event

Groundwater samples were collected from 10 existing shallow wells (PEN-3221-01 to PEN-3221-10), seven new shallow wells (PEN-44-09 to PEN-44-15), and two new deep wells (PEN-44-18 and PEN-44-19) were analyzed for the full USEPA TCL analytes including VOCs, SVOCs, PAHs, Pesticides and PCBs, TAL metals, and TRPH.

May 2005 Groundwater Sampling Event

Groundwater samples were collected from five new shallow wells (PEN-44-15, PEN-44-16, PEN-44-20 to PEN-44-22) and analyzed only for cVOCs as part of the cVOC delineation of groundwater. Additionally, based on the laboratory analytical results from the December 2005 sampling event 1, four monitoring wells were resampled for analytes that were detected at concentrations exceeding regulatory screening criteria. The groundwater samples were analyzed at the listed monitoring wells as follows:

- PEN-3221-03 was analyzed for manganese;
- PEN-44-15 was analyzed for bis(2-ethylhexyl)phthalate;
- PEN-44-18 was analyzed for iron and manganese; and
- PEN-44-19 was analyzed for iron, manganese, and bis(2-ethylhexyl)phthalate).

August 2005 Groundwater Sampling Event

Groundwater samples were collected from four new shallow monitoring wells (PEN-44-23 to PEN-44-26) and analyzed only for cVOCs (Figures 10-5 and 10-6).

Summary of Groundwater Sampling Events

Concentrations of pesticides, PCBs, and TRPH were less than the laboratory detection limits were not detected in the groundwater samples collected during the first sampling event and were not analyzed in subsequent sampling events. Four VOCs, including chloroform, chloromethane, 1,1-DCA, and cis 1,2-DCE were detected in groundwater samples, but were at concentrations less than their GCTLs.

Bis(2-ethylhexyl)phthalate was detected at concentrations greater than its Florida GCTL in groundwater samples from two of the monitoring wells. Each of these monitoring wells was resampled in May 2006. The detected bis(2-ethylhexyl)phthalate concentrations were less than the laboratory detection limit (Figure 4-5).

Sixteen metals were detected in the groundwater samples collected at Site 44. Three of the metals (aluminum, iron, and manganese) were detected at concentrations exceeding Florida GCTLs (Figure 4-5). Aluminum was detected in most of the monitoring wells sampled for the RI at concentrations exceeding its secondary CTL, but less than the NAS Pensacola background concentration. Iron and manganese were also detected in groundwater samples at concentrations exceeding their secondary CTLs, but were less than their NAS Pensacola background concentrations.

TCE was detected at concentrations exceeding its Florida CTL per in groundwater samples collected from six shallow monitoring wells (Figure 4-5). One of these six monitoring well locations, PEN-3221-09, which was installed as part of the UST investigation, previously had TCE exceedances. Other monitoring wells installed during the UST investigation that previously had PCE or TCE exceedances did not have any exceedances during the RI sampling. The other monitoring well locations where TCE exceeded the Florida CTL were north from the northwest corner of Building 3221 include: PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, and PEN-44-24.

A2.3 Human Health Risk Assessment

The results of the USEPA human health risk assessment (HHRA) for receptors exposed to soil and/or groundwater at Site 44 indicated the following:

- Risks for exposure to COPCs in surface and subsurface soil are within the USEPA's target risk range of $1x10^{-4}$ to $1x10^{-6}$ for all receptors.
- Risks exceed $1x10^{-4}$ for exposure to TCE in groundwater by the hypothetical future resident, which exceeds USEPA's target risk range of $1x10^{-4}$ to $1x10^{-6}$.

The HHRA also took into account various Florida soil and groundwater criteria per Chapter 62-777 F.A.C. to evaluate exposure to COPCs and to establish preliminary remediation goals as part of the CERCLA RI/FS process in accordance with National Contingency Plan (NCP) requirements. The soil criteria include SCTLs for direct contact (i.e., ingestion, dermal contact, and inhalation), SCTLs for leachability to groundwater, and background levels for metals. The groundwater criteria include CTLs for direct contact with groundwater (based on ingestion) and background levels for metals. Risks were evaluated for industrial workers, trespassers, and maintenance workers. Using criteria developed according to Chapter 62-777, F.A.C., it was determined that:

- Risks associated with exposure to cPAHs in surface soil exceeded Florida's SCTLs for hypothetical future residents and lifelong recreational users.
- Risks associated with exposure to cPAHs in subsurface soil exceeded Florida's SCTLs for hypothetical future residents.

Using criteria developed according to Chapter 62-550 F.A.C., it was determined that TCE contamination in the groundwater exceeded the Florida CTL of 3 µg/L which is based upon the Florida Drinking Water MCL, and is more stringent than the USEPA Safe Drinking Water Act MCL of 5 µg/L.

Based on the Florida risk evaluation the maximum detected cPAH concentrations in surface soil was greater than the Florida industrial SCTL, but was less than 3 times the Florida industrial SCTL. Therefore, "Hot spots" would not be considered present assuming the reasonably anticipated future land use at Site 44 is non-residential (commercial/industrial-type uses).

A.2.4 Ecological Risk Assessment

An Ecological Risk Assessment was performed during the RI (2008) to evaluate whether ecological receptors are potentially at risk when exposed to chemicals at Site 44. The ecological risk assessment found that the overall level of ecological risk associated with detected contaminants is negligible and that no action is required at Site 44 to protect ecological receptors.

A.2.5 RI Summary

Potential source areas investigated during the RI include the perimeter of the foundation of former Building 3629, which had been used for flammable liquid storage; the former staging area located to the northeast of Building 3629, in a grid pattern at the wash rack to provide full coverage of the area; at the approximate location of UST 3221 SW; and the southwest side of Building 3221 which included a former materials staging area that was marked on the concrete. The RI concluded after the investigation of these areas that a release of contaminants at Site 44 may have resulted from routine aircraft maintenance activities and storage of materials used in these activities. Based on the data obtained for the RI, the source and nature of materials, as well as the time of disposal, could not be identified.

Soil screening for VOCs with the mobile laboratory identified one soil boring location with a detectable concentration of PCE that was below its regulatory screening criteria. Delineation of cPAHs identified an area around the foundation of former Building 3629. Four soil boring locations (44SB02, 44SB31, 44SB34, and 44SB47) had benzo(a)pyrene equivalent concentrations exceeding the Florida residential direct exposure SCTL.

Water level measurements indicated that shallow groundwater at Site 44 flows from southwest to northeast. Groundwater analytical results indicated that concentrations of petroleum related constituents were below state standards.

TCE was detected at concentrations exceeding the Florida CTL at the location of six shallow monitoring wells (Figure 4-6). The TCE plume was identified in the vicinity of PEN-3221-09, which was installed as part of the UST investigation and previously had TCE exceedances. The other monitoring wells in the

plume extend north from the northwest corner of Building 3221, and include monitoring wells PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, and PEN-44-24.

A.2.6 Feasibility Study

Based on the results of the RI, a Feasibility Study (FS) was completed in 2010 to establish Remedial Action Objectives (RAOs); cleanup goals, to screen remedial technologies; and to assemble, evaluate, and compare remedial alternatives (Tetra Tech, 2010). The RAOs are established to protect human health and the environment and comply with all pertinent federal and state regulations. Site-specific RAOs specify chemicals of concern (COCs), media of interest, exposure pathways, and cleanup goals or acceptable contaminant concentrations. The following site-specific RAOs were developed to protect the public from potential current and future health risks, as well as to protect the environment:

- Prevent unacceptable human health risk to surface and subsurface soil with cPAH concentrations exceeding the Florida residential direct exposure and site-specific recreational SCTLs.
- Prevent unacceptable human health risk associated with exposure to groundwater with TCE concentrations exceeding the Florida CTL.
- Restore groundwater beneath this site (which is classified by Florida as potential drinking water) to meet the Florida drinking water CTL.

Based on the results of the screening of remediation technologies, remedial alternatives were developed for soil and groundwater at Site 44. Remedial alternatives, or cleanup options, were identified in the Site 44 FS because they would meet the RAOs identified above. These alternatives are different combinations of plans to restrict access and to contain, remove, or treat contamination to protect human health and the environment. The remedial alternatives identified for soil were (Alternative S-0) No Action and (Alternative S-1) Land Use Controls (LUCs). The remedial alternatives identified for groundwater were (Alternative G-0) No Action, (Alternative G-1) Natural Attenuation, LUCs, and Monitoring, and (Alternative G-2) In-Situ air sparging (AS)/soil vapor extraction (SVE) of the TCE Plume, Natural Attenuation, LUCs, and Monitoring.

Cleanup goals for Site 44 use SCTLs per Chapter 62-777 F.A.C. to establish preliminary remediation goals as part of the CERCLA RI/FS process and are the soil cleanup levels that will be presented in a Record of Decision consistent with federal National Contingency Plan (NCP) requirements. Site 44 cleanup goals for the current and reasonably anticipated future land use were developed in the FS for the soil COC, cPAHs (evaluated collectively as benzo(a)pyrene equivalents), and the groundwater COC, TCE, and were based on state and/or federal criteria, as follows:

- cPAHs in surface and subsurface soil – 700 micrograms per kilogram (µg/kg) (Florida industrial direct exposure SCTL).
- TCE in groundwater – 3 µg/L (Florida CTL).

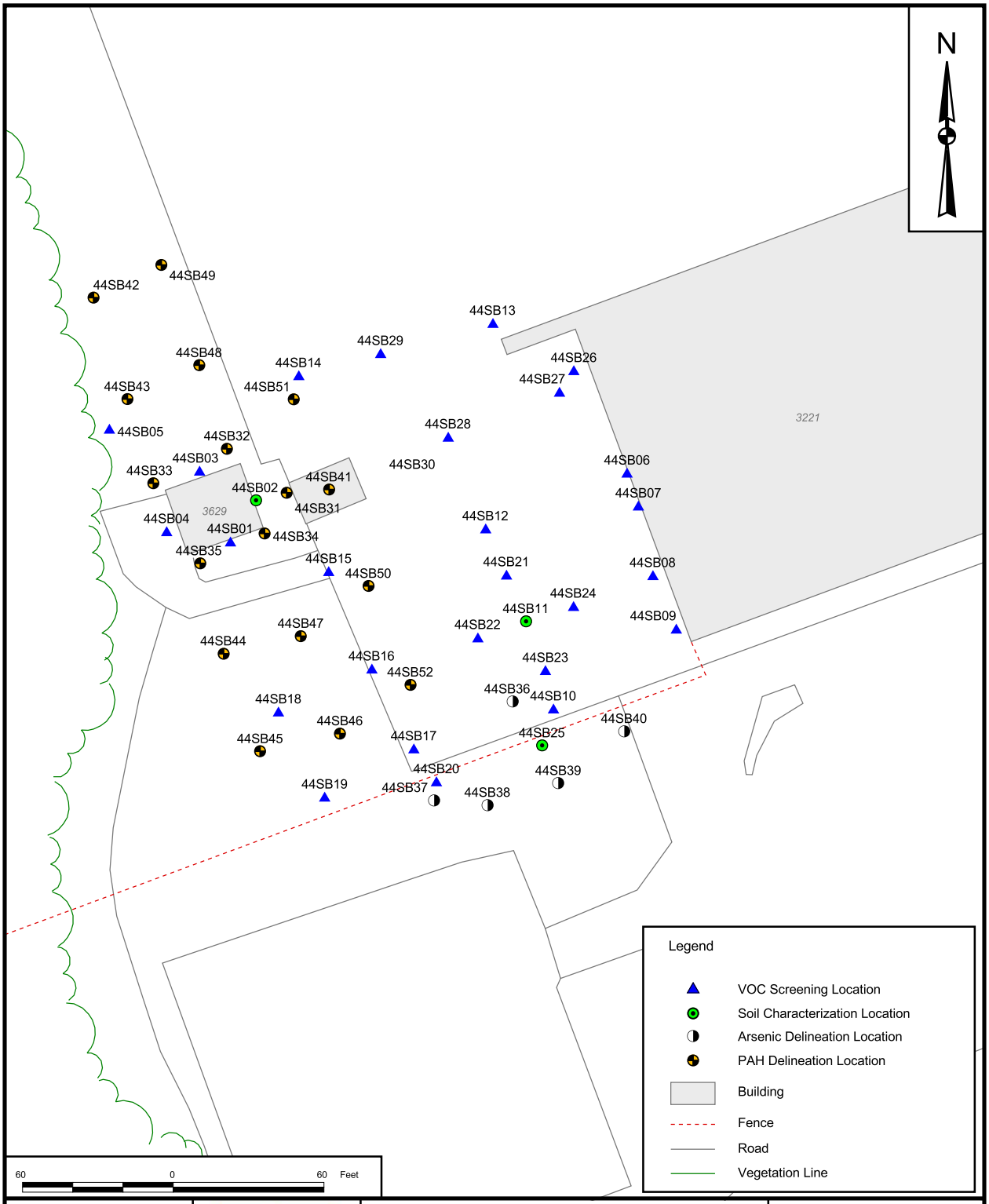
The remedial actions developed in the FS will prevent exposure by hypothetical future residents and lifelong recreational users/trespassers to soil with cPAHs at current concentrations, which are greater than the Florida residential direct exposure SCTL for cPAHs, and reducing TCE concentrations in groundwater to less than the Florida MCL.

A.2.7 Proposed Plan

A Proposed Plan was completed in 2011 to present findings from the RI/FS and to propose a preferred remedial alternative. The preferred remedial alternative for Site 44 was presented as a combination of Alternative S-1 for soil: LUCs to maintain current site conditions for industrial/commercial SCTLs, and G-1 for groundwater: natural attenuation, monitoring and LUCs. Groundwater sampling locations will be determined in a Natural Attenuation Monitoring Plan following the completion of the Record of Decision.

The preferred alternatives (S-1 and G-1) are expected to allow Site 44 to be used for the reasonably anticipated future land use, which is non-residential. In addition, implementation of LUCs would prevent unacceptable risks to human health during the period that natural attenuation of TCE in groundwater is occurring.

APPENDIX A2 FIGURES



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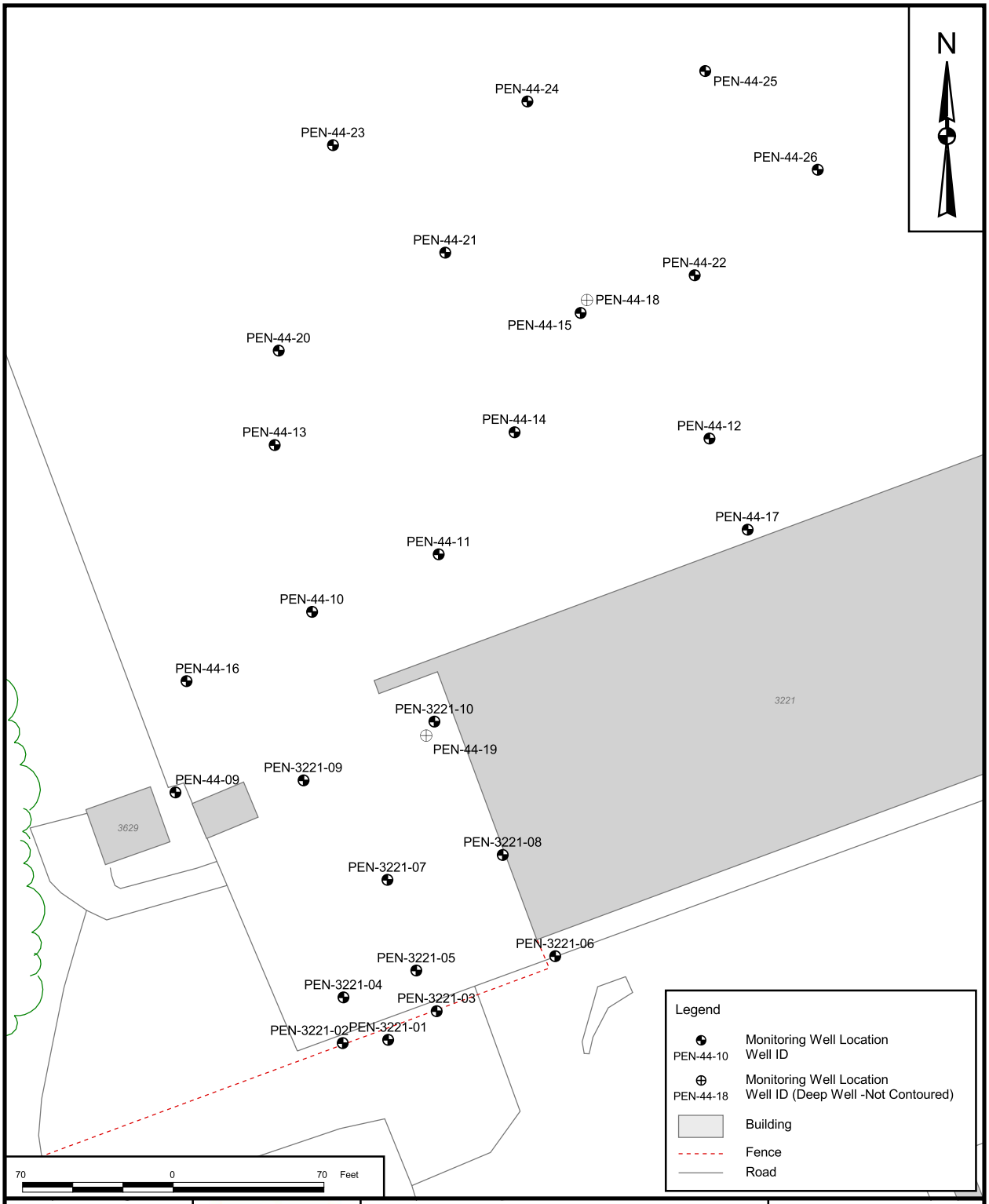
CHECKED BY	DATE		SITE 44 RI REPORT	APPROVED BY / DATE
B. OLSON	5/03/07		NAS PENSACOLA	APPROVED BY / DATE
COST/SCHEDULE-AREA			PENSACOLA, FLORIDA	DRAWING NO. FIGURE 2-1 / REV 0
SCALE AS NOTED		NAVFAC		

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR SB LOCATION SITE 44 LAYOUT 5/03/07 JEE



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CHECKED BY	DATE		SITE 44 RI REPORT	APPROVED BY / DATE
B. OLSON	5/03/07		NAS PENSACOLA	APPROVED BY / DATE
COST/SCHEDULE-AREA			PENSACOLA, FLORIDA	DRAWING NO. FIGURE 2-2 / REV 0
SCALE AS NOTED		NAVFAC		

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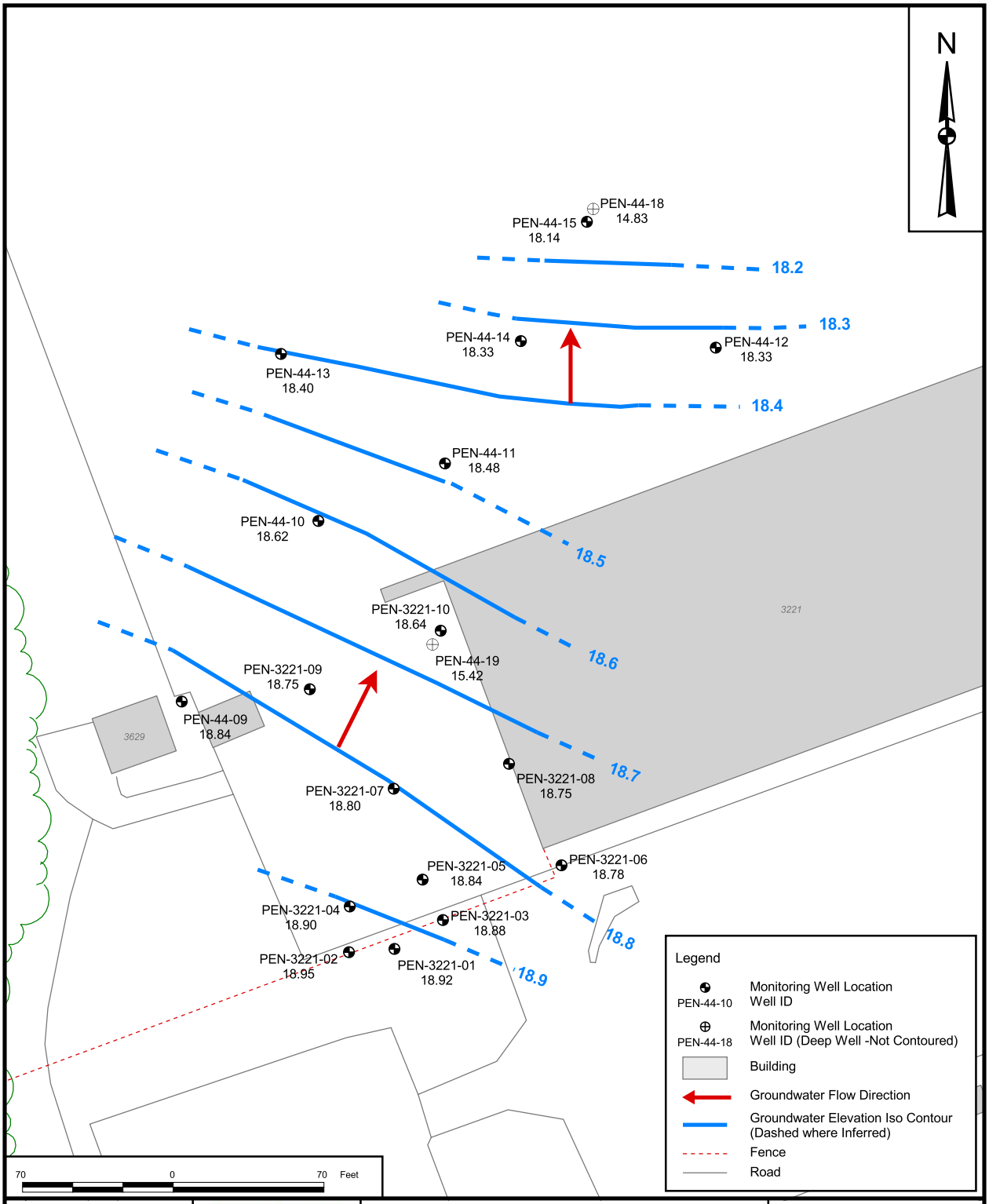

DRAWN BY	DATE		CONTRACT NUMBER
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CHECKED BY	DATE	SHALLOW MONITORING WELLS 12/06/05	APPROVED BY / DATE
B. OLSON	5/03/07	SITE 44 RI REPORT	— / —
COST/SCHEDULE-AREA		NAS PENSACOLA	APPROVED BY / DATE
		PENSACOLA, FLORIDA	— / —
SCALE			DRAWING NO. / REV
AS NOTED			FIGURE 3-2 / 0

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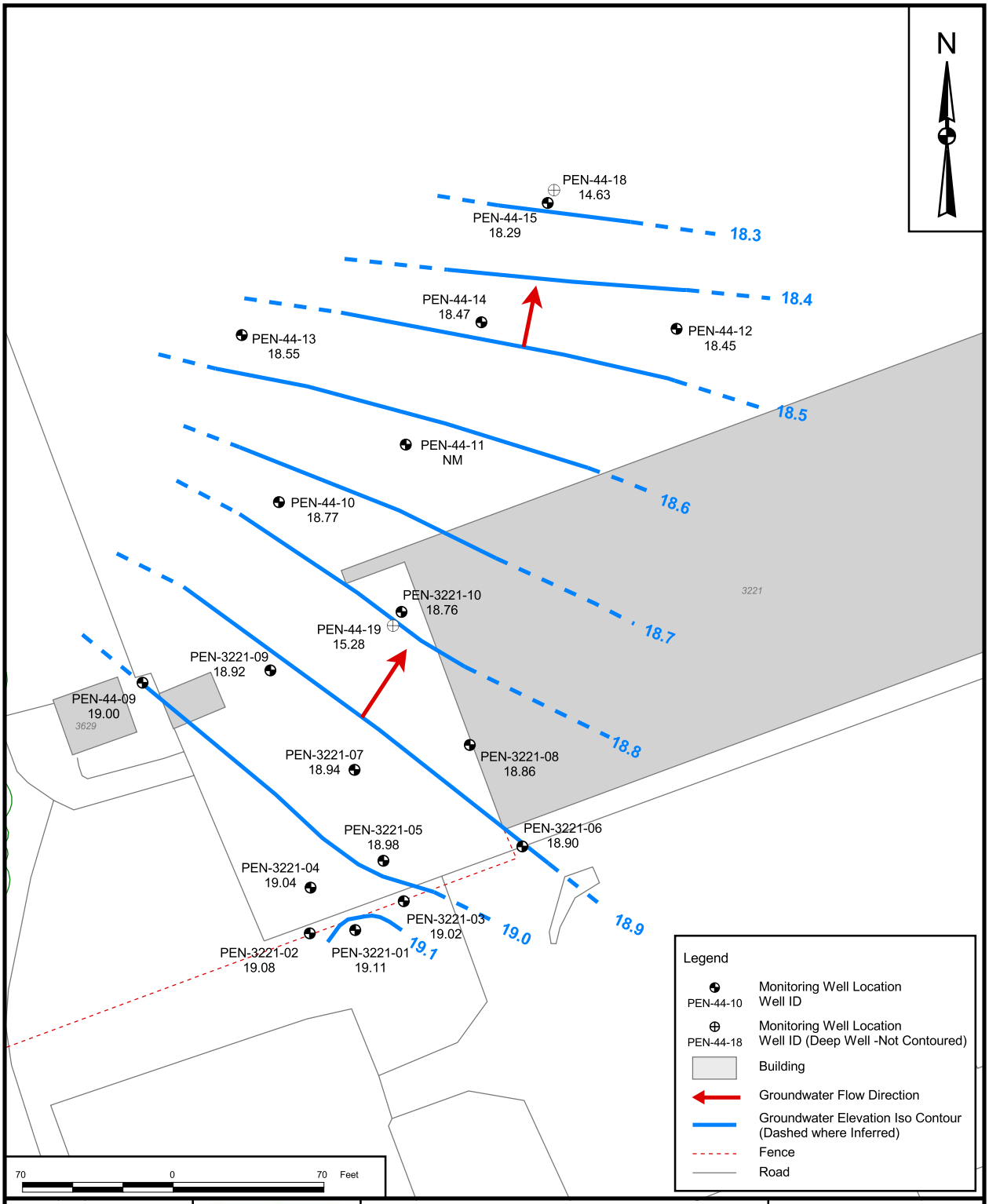

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CHECKED BY B. OLSON	DATE 5/03/07		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-3 / REV 0

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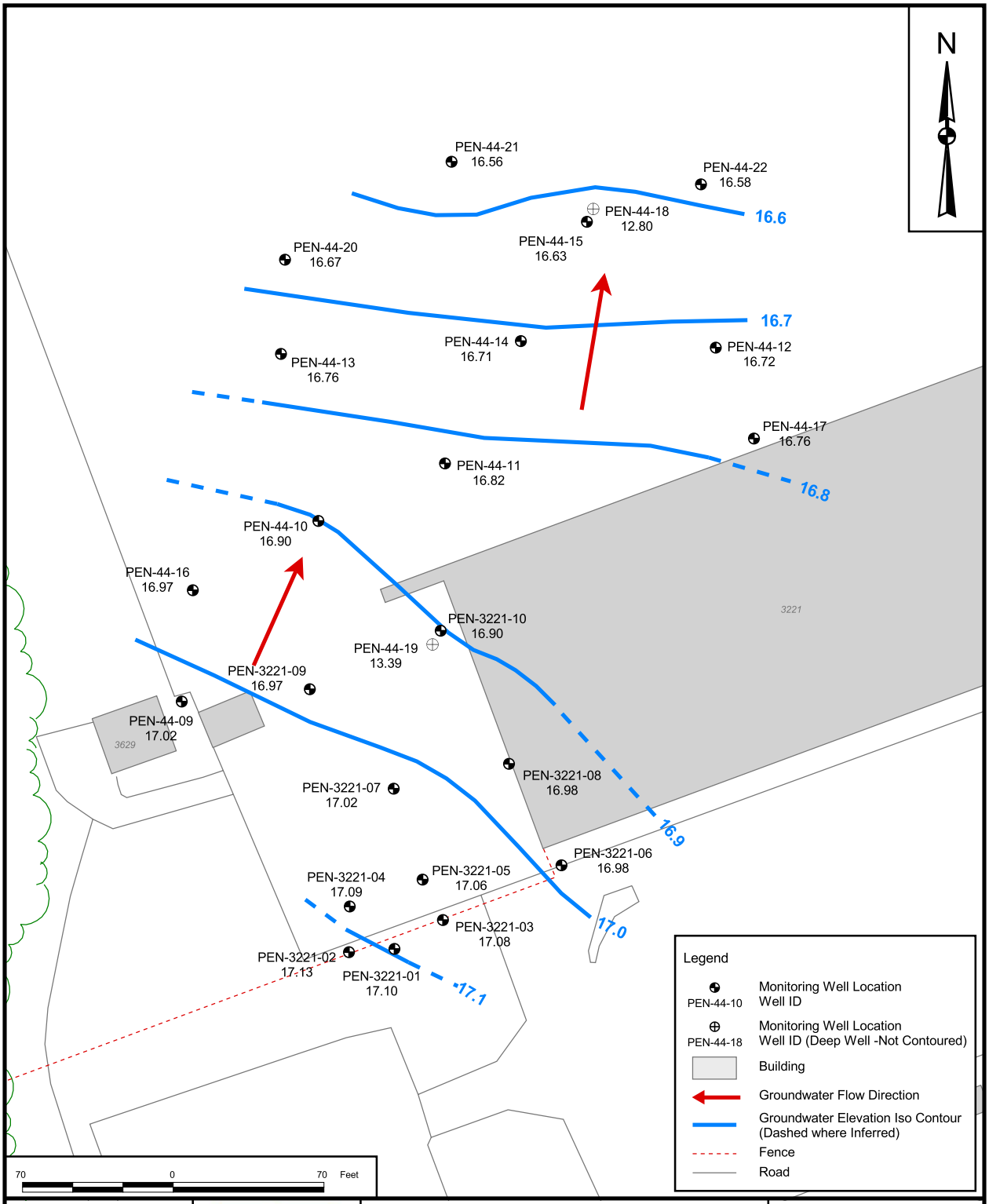

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CHECKED BY B. OLSON	DATE 4/25/07		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-4 / REV 0

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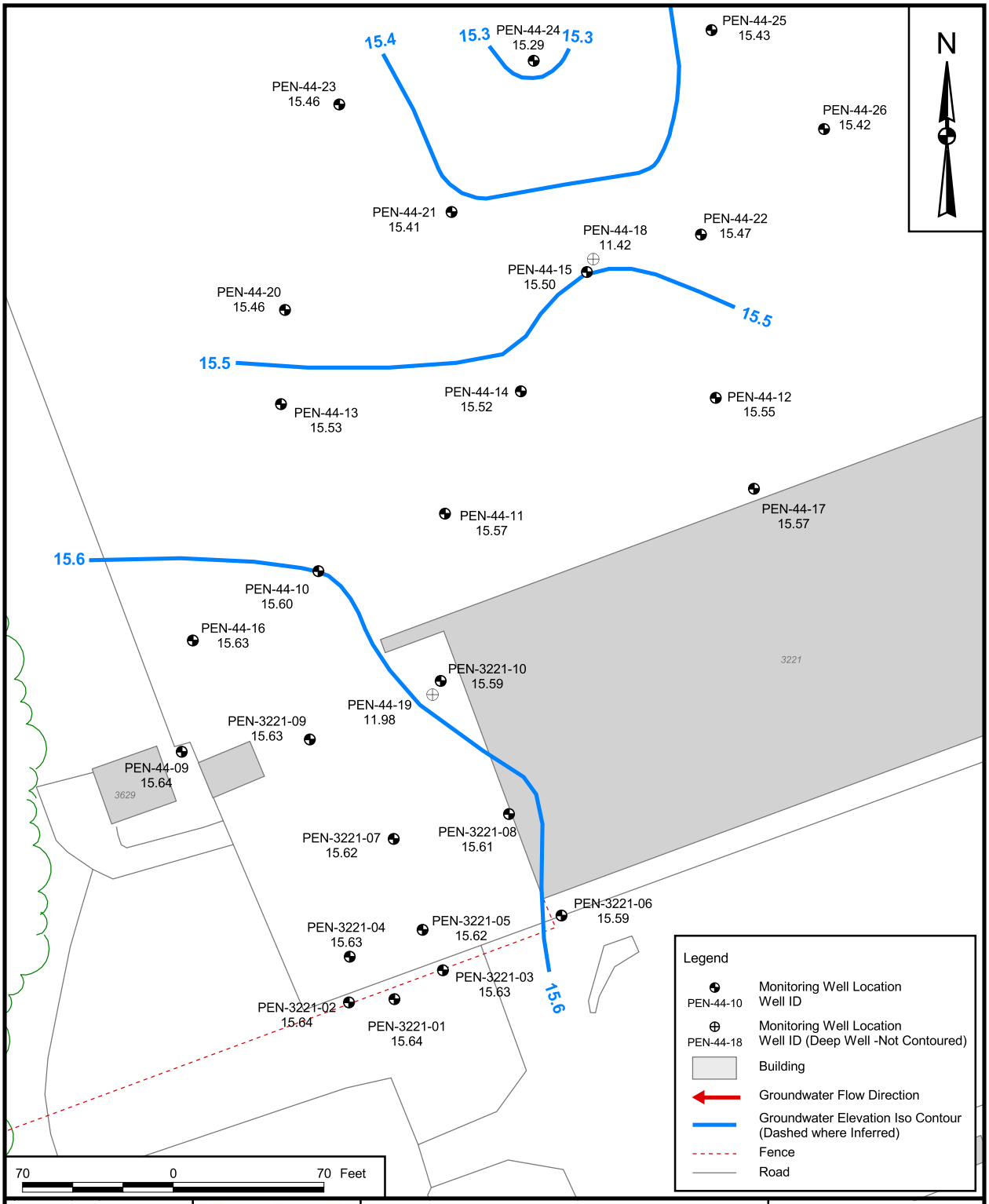

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CHECKED BY B. OLSON — DATE 4/25/07			APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-5 — REV 0

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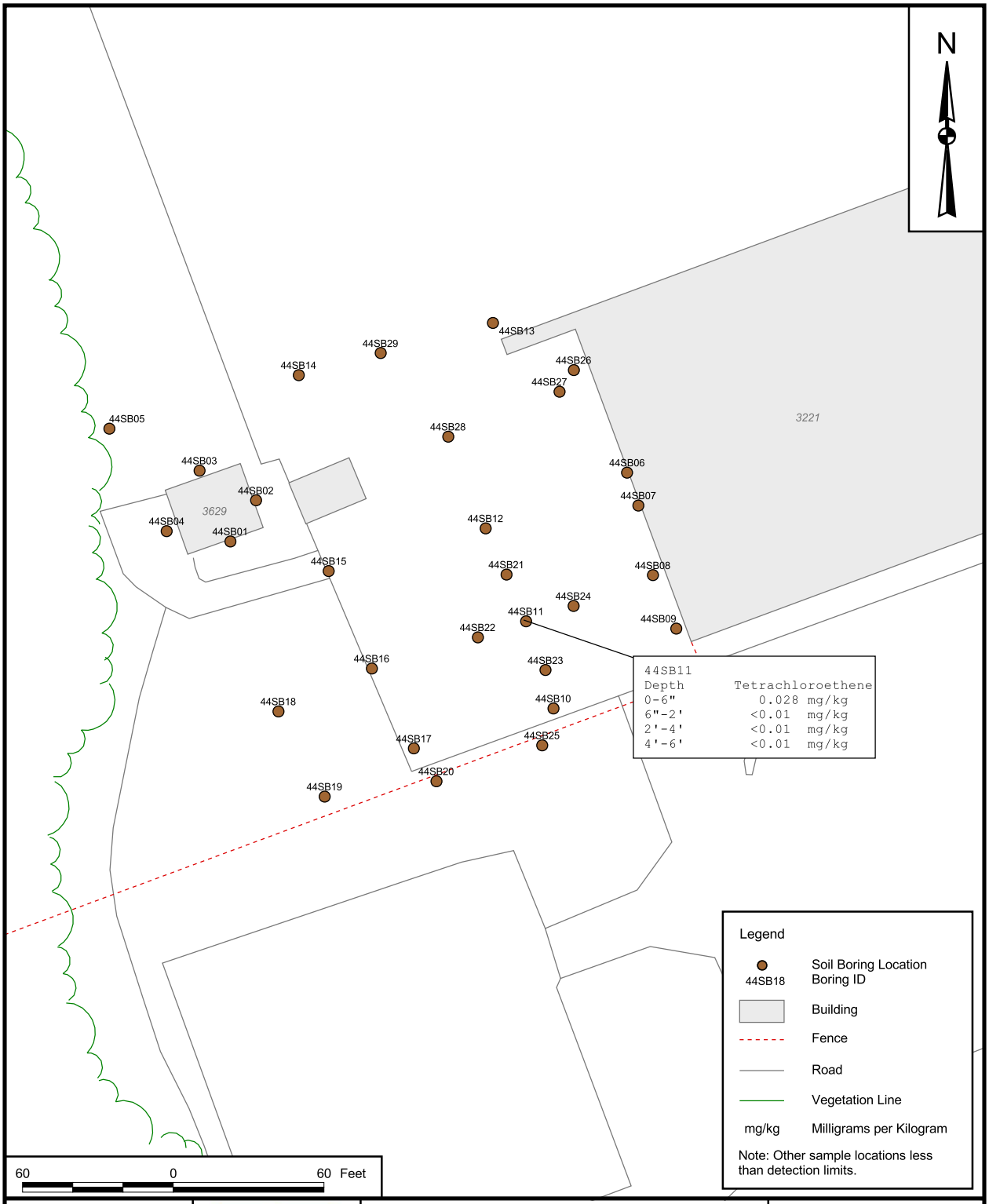

DRAWN BY	DATE			CONTRACT NUMBER
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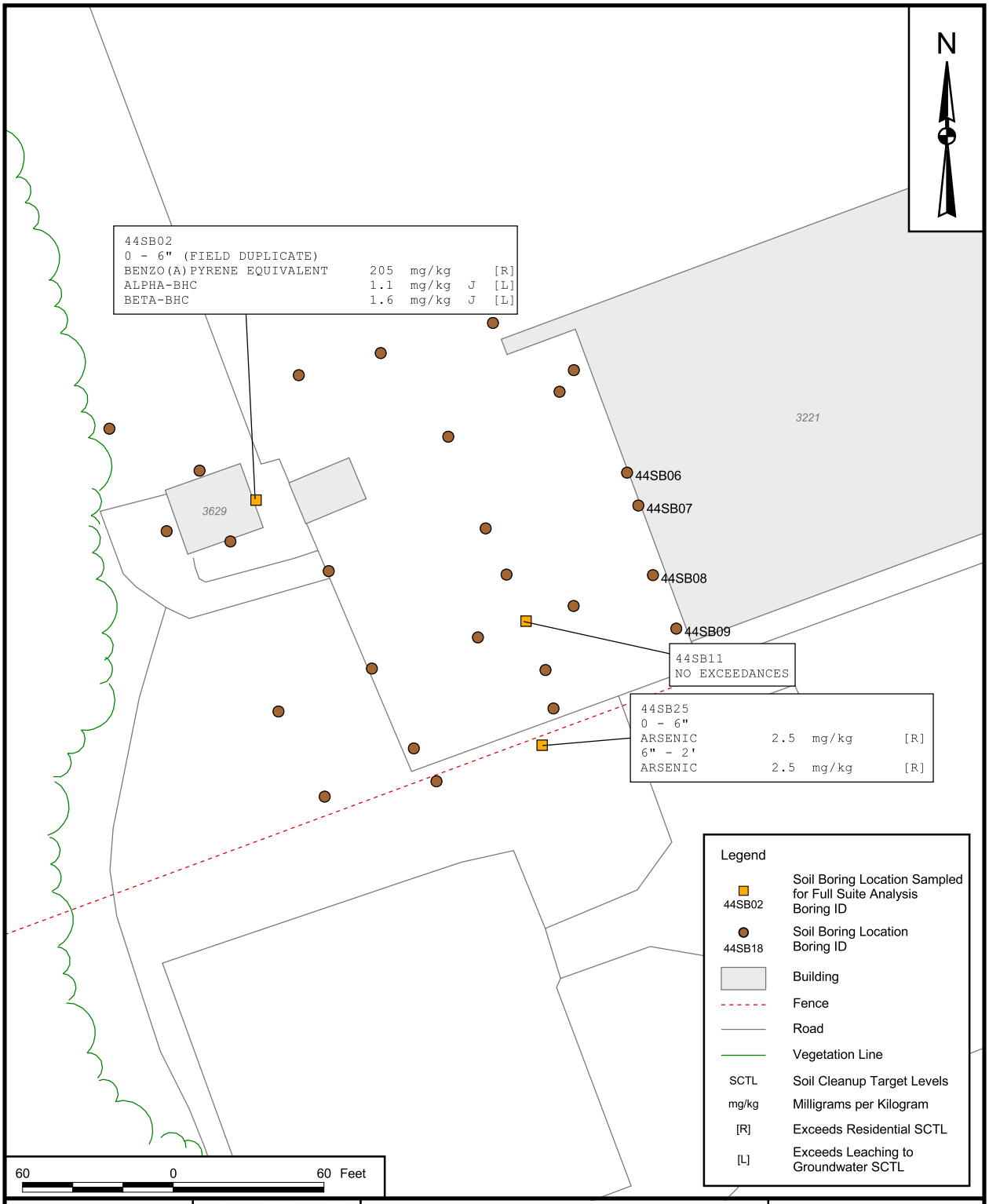
CHECKED BY	DATE			APPROVED BY / DATE
B. OLSON	5/03/07			— / —
COST/SCHEDULE-AREA				APPROVED BY / DATE
				— / —
SCALE				DRAWING NO. / REV
AS NOTED				FIGURE 4 - 1 / 0

SOIL SCREENING DETECTIONS
SITE 44 RI REPORT
NAS PENSACOLA
PENSACOLA, FLORIDA

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR SOIL RESULTS SITE 44 LAYOUT 5/03/07 JEE



DRAWN BY	DATE		SOIL CHARACTERIZATION SCTL EXCEEDANCES	CONTRACT NUMBER
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CHECKED BY	DATE		NAS PENSACOLA	APPROVED BY — DATE —
B. OLSON	5/03/07		PENSACOLA, FLORIDA	APPROVED BY — DATE —
COST/SCHEDULE-AREA				DRAWING NO. FIGURE 4 - 2 / REV 0
SCALE AS NOTED				

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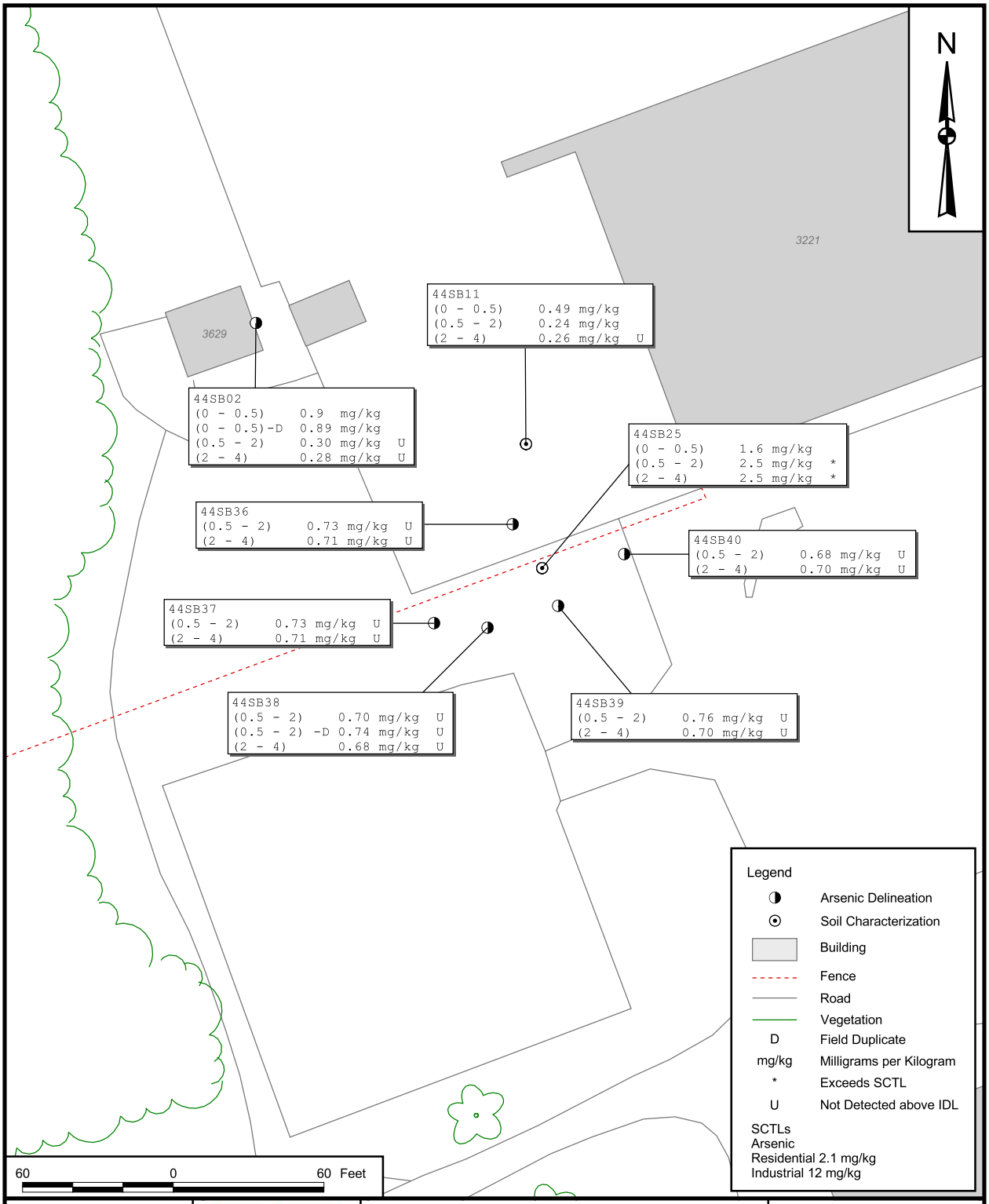

DRAWN BY S. STROZ	DATE 12/13/06	ARSENIC IN SOIL DELINEATION SITE 44 RI REPORT NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0367
CHECKED BY B. OLSON	DATE 4/25/07		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 4-3 REV 0

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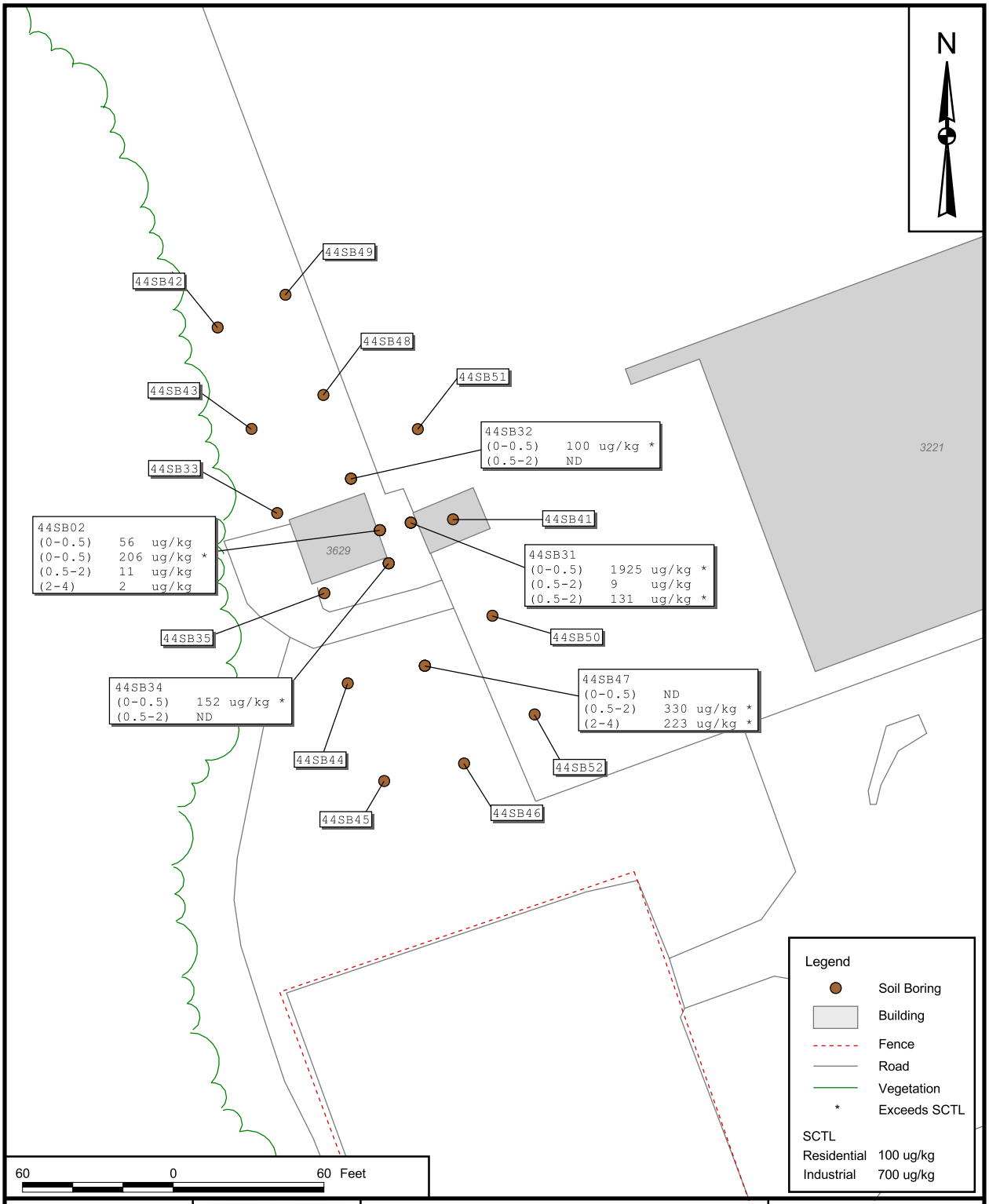

DRAWN BY	DATE			CONTRACT NUMBER
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CHECKED BY	DATE		SCTL EXCEEDANCES IN SOIL	APPROVED BY / DATE
B. OLSON	12/15/06		SITE 44 RI REPORT	APPROVED BY / DATE
COST/SCHEDULE-AREA			NAS PENSACOLA	
SCALE			PENSACOLA, FLORIDA	DRAWING NO. / REV
AS NOTED				FIGURE 4-4 / 0

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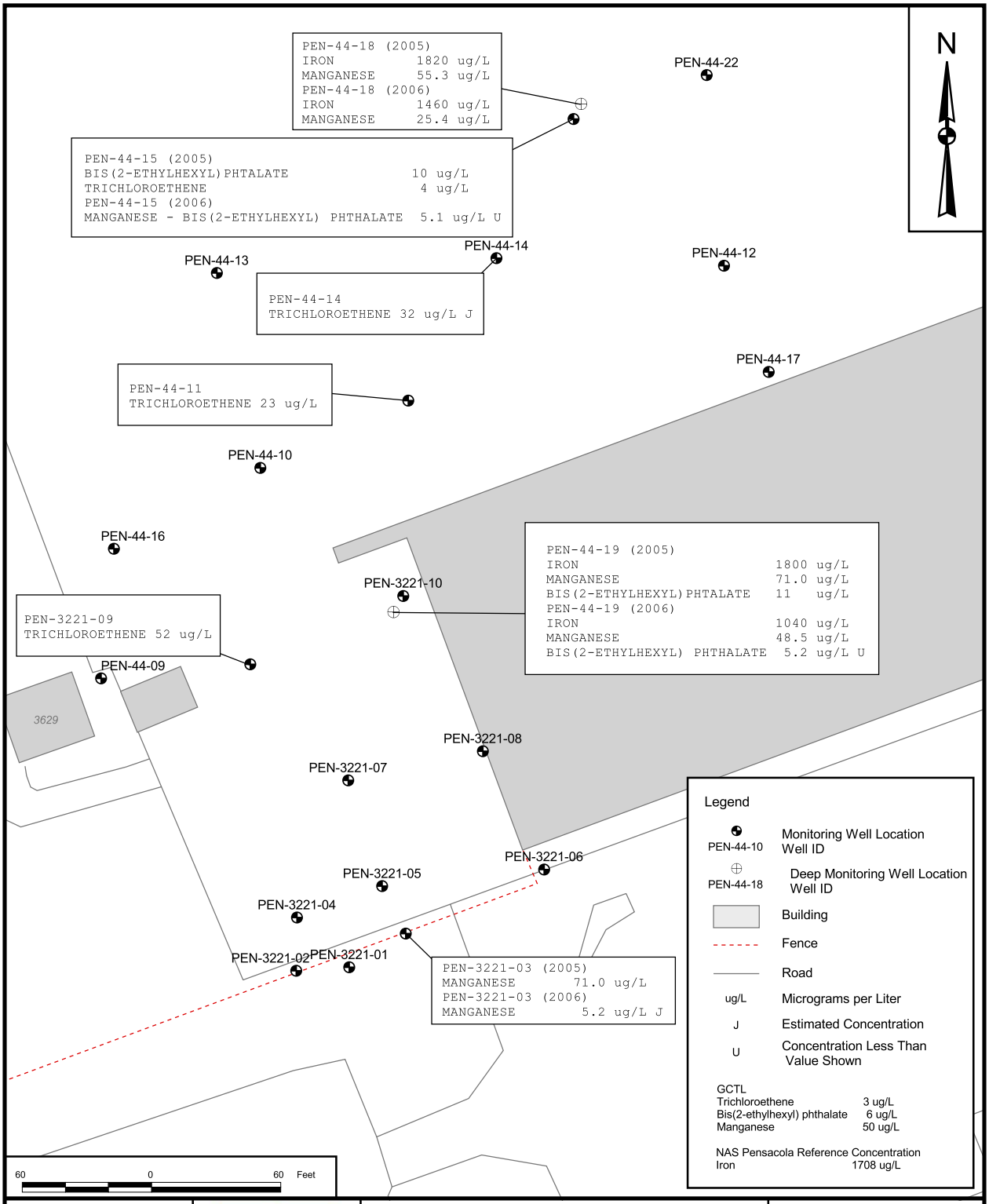

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CHECKED BY	DATE		NAS PENSACOLA	APPROVED BY — DATE —
B. OLSON	5/03/07		PENSACOLA, FLORIDA	APPROVED BY — DATE —
COST/SCHEDULE-AREA				DRAWING NO. FIGURE 4 - 5 / REV 0
SCALE AS NOTED		NAVFAC		

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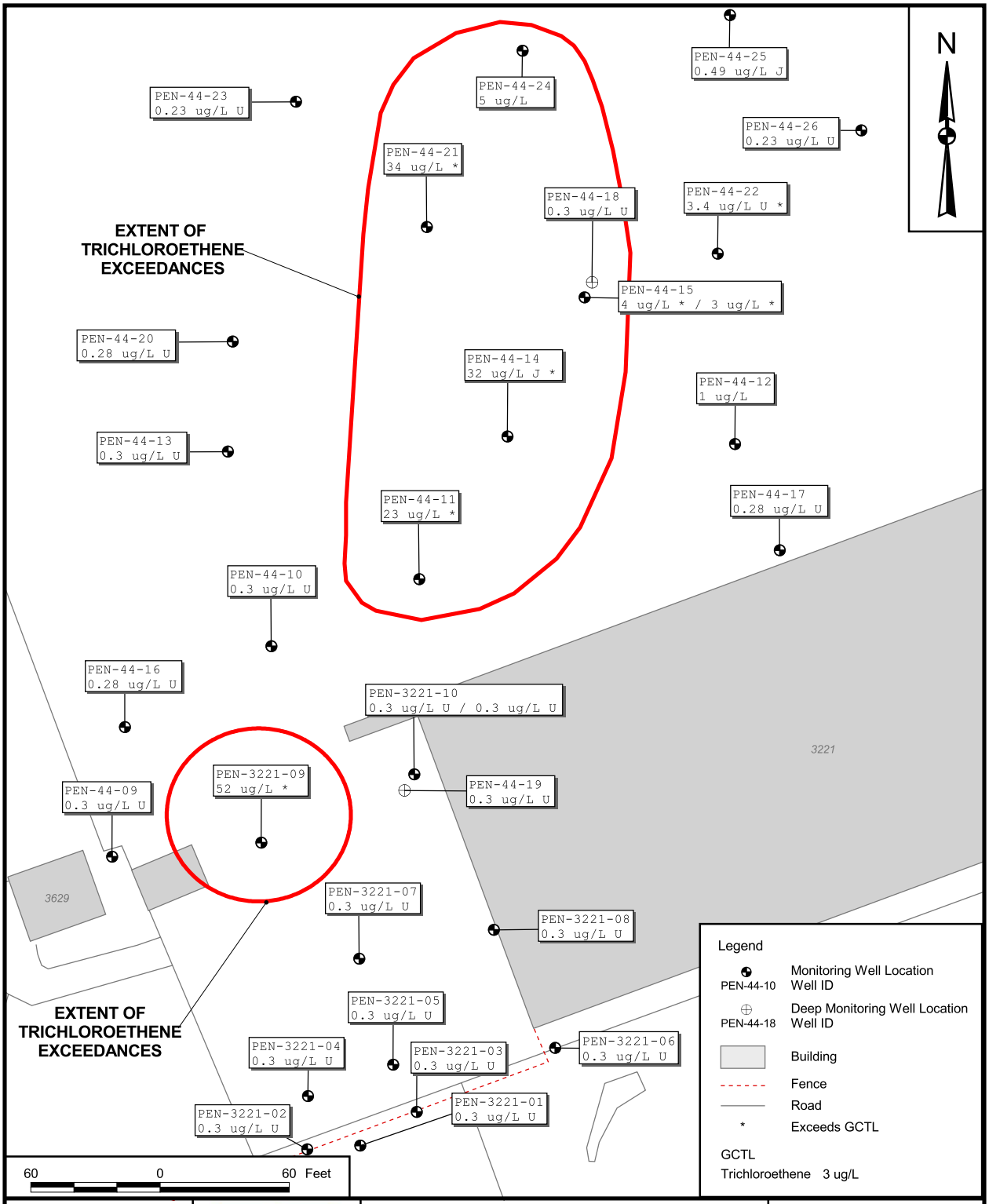

DRAWN BY	DATE		CONTRACT NUMBER
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CHECKED BY	DATE		APPROVED BY — DATE —
B. OLSON	5/03/07		APPROVED BY — DATE —
COST/SCHEDULE-AREA			DRAWING NO. FIGURE 4 - 6 / REV 0
SCALE AS NOTED			

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APPENDIX B

FIELD STANDARD OPERATING PROCEDURES AND FIELD FORMS

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Sample and Evidence Management**

Effective Date: November 1, 2007	**Number:** SESDPROC-005-R1

Authors

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Title: Environmental Scientist, Regional Expert
Signature: Date: 11/6/07

Approvals

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Title: Chief, Ecological Assessment Branch
Signature: Date: 10/31/07

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Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Date: 10/31/07

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-005-R1, *Sample and Evidence Management*, replaces SESDPROC-005-R0 **General** Updated referenced procedures to reflect most recent version. Replaced “shall” with “will”. **Cover Page:** Changed title for Antonio Quinones from Environmental Investigation Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove’s title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that procedure is located on the H: drive of the LAN. **Section 1.4** Added reference for the SESD Operating Procedure for Control of Records. Alphabetized and revised the referencing style for consistency. **Section 2.2.3** Added that Confidential Business Information will be handled in accordance with SESD Operating Procedure for Control of Records.	November 1, 2007
SESDPROC-005-R0, Sample and Evidence Management, Original Issue	February 05, 2007

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Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed by SESD field investigators when handling and managing samples and other types of evidence after their collection and during delivery to the laboratory.

1.2 Scope/Application

The procedures contained in this document are to be used by field investigators when handling and managing samples and other evidence collected to support SESD field investigations. On the occasion that SESD field investigators determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

USEPA Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), November 2001

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

SESD Operating Procedure for Packing, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

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2 Sample and Evidence Identification

2.1 Introduction

Sample identification, chain-of-custody records, receipt for sample records, and other field records will be legibly recorded with waterproof, non-erasable ink, unless otherwise specified. If errors are made in any of these documents, corrections will be made by crossing a single line through the error and entering the correct information. All corrections must be initialed and dated. If possible, all corrections should be made by the individual making the error.

Following are definitions of terms used in this section:

Field Investigator
Any individual who performs or conducts field sampling, observation and/or measurement activities in support of field investigations

Project Leader
The individual with overall responsibility for conducting a specific field investigation in accordance with this procedure

Field Sample Custodian
Individual responsible for identifying the sample containers and maintaining custody of the samples and the Chain-of-Custody Record

Sample Team Leader
An individual designated by the project leader to be present during and responsible for all activities related to the collection of samples by a specific sampling team

Sampler
The individual responsible for the actual collection of a sample

Transferee
Any individual who receives custody of samples subsequent to release by the field sample custodian

Laboratory Sample Custodian
Individual responsible for accepting custody of samples from the field sample custodian or a transferee

One individual may fulfill more than one of the roles described above.

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2.2 Sample and Evidence Identification Procedures

2.2.1 Sample Identification

The method of sample identification used depends on the type of sample collected. Field measurement samples are those collected for specific field analysis or measurement where the data are recorded directly in bound field logbooks or on the Chain-of-Custody Record. Examples of field measurements and analyses include XRF, pH, temperature, dissolved oxygen and conductivity. Samples collected for laboratory analysis will be identified by using a stick-on label or a tag which is attached to the sample container. In some cases such as biological samples, the label or tag may have to be affixed to a bag containing the sample. If a sample tag is used, the sample should be placed in a bag, then the sample and the tag will be placed in a second bag.

The following information will be included on the sample label or tag using waterproof, non-erasable ink:

- Project number;
- Field identification or sample station number;
- Date and time of sample collection;
- Designation of the sample as a grab or composite;
- Whether the sample is preserved or unpreserved;
- The general types of analyses to be performed; and
- Relevant comments (such as readily detectable or identifiable odor, color, or known toxic properties).

2.2.2 Photograph, Digital Still Image and Video Identification

Photographs and Digital Still Images

When photographs or digital images are taken for purposes of documenting and supporting a field investigation, a record of each exposure or image will be kept in a bound field logbook. The following information will be recorded in the logbook:

- An accurate description of what the photograph or image shows, including orientation, if appropriate;
- The date and time that the photograph or image was taken;

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- The name of the individual who took the photograph or digital image.

When photographs are taken with a film camera, the film should be developed with the negatives supplied uncut, if possible. The identifying information that was recorded in the field logbook will be entered on the back of the prints.

When digital images are obtained during a field investigation, an electronic copy and a printed copy of the unaltered investigation-related images will be placed in the official files. For enforcement cases, it is imperative that the individual who took the image be identified in the field logbook in the event their testimony is required.

Video

When a video recording is used as evidence in an enforcement case, the following information should be recorded in a bound field logbook:

- The date and time that the video was recorded;
- A brief description of the subject of the video;
- The person recording the video.

An audio record may also be included in the video tape with the above logistical information, as well as a narrated description of the video record.

A label will be placed on the video media with the appropriate identifying information (i.e., project name, project number, date, location etc.). In the event testimony regarding a video recording is required for an enforcement case, one individual should be responsible for recording the video for each case. The original, unaltered recording will be placed in the official files.

2.2.3 Identification of Physical Evidence

Physical evidence, other than samples, will be identified, when possible, by recording the necessary information on the evidence. When samples are collected from vessels or containers which can be moved (drums for example), the vessel or container should be marked with the field identification or sample station number for future identification. The vessel or container may be labeled with an indelible marker (e.g., paint stick or spray paint). The vessel or container need not be marked if it already has a unique marking; however, these markings will be recorded in the bound field logbooks. In addition, it is suggested that photographs of any physical evidence (markings, etc.) be taken and the necessary information recorded in the field logbook.

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Occasionally, it is necessary to obtain copies of recorder and/or instrument charts from facility owned analytical equipment, flow recorders, etc., during field investigations and inspections. Record the following information on copies of the charts:

- Starting and ending time(s) and date(s) for the chart;
- An instantaneous measurement of the media being measured by the recorder will be taken and entered at the appropriate location on the chart along with the date and time of the measurement; and
- A description of the location being monitored and other information required to interpret the data such as type of flow device, chart units, factors, etc.

The field investigator will indicate who the chart (or copy of the chart) was received from and enter the date and time, as well as the field investigator's initials.

Documents such as technical reports, laboratory reports, etc., should be marked with the field investigator's signature, the date, the number of pages, and from whom they were received. Documents that are claimed by a facility to be “confidential” and, therefore, potentially subject to the Confidential Business Information requirements, will be handled in accordance with SESD Operating Procedure for Control of Records (SESDPROC-002).

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3 Chain-of-Custody Procedures

3.1 Introduction

Chain-of-custody procedures are comprised of the following elements: 1) maintaining custody of samples or other evidence, and 2) documentation of the chain-of-custody for evidence. To document chain-of-custody, an accurate record must be maintained to trace the possession of each sample, or other evidence, from the moment of collection to its introduction into evidence.

3.2 Sample Custody

A sample or other physical evidence is in custody if:

- It is in the actual possession of an investigator;
- It is in the view of an investigator, after being in their physical possession;
- It was in the physical possession of an investigator and then they secured it to prevent tampering; and/or
- It is placed in a designated secure area.

3.3 Documentation of Chain-of-Custody

The following are used to identify and demonstrate how sample integrity is maintained and custody is ensured.

Sample Identification
A stick-on sample label or a tag should be completed for each sample container using waterproof, non-erasable ink as specified in Section 2.2.1.

Sample Seals
If appropriate, samples should be sealed as soon as possible following collection using a custody seal with EPA identification. The sample custodian or project leader will write the date and their initials on the seal. Except for criminal investigations, the use of custody seals may be waived if field investigators keep the samples in their custody as defined in Section 3.2, from the time of collection until the samples are delivered to the laboratory analyzing the samples. Custody seals must always be used for criminal investigations.

Field Sample Custodian
The field sample custodian is the person designated by the project leader to receive and manage custody of samples while in the field, including labeling and custody sealing.

Chain-of-Custody Record

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The field Chain-Of-Custody record is used to document the custody of all samples or other physical evidence collected and maintained by investigators. All physical evidence or samples will be accompanied by a Chain-Of-Custody Record. This form may be generated by the FORMS computer program (Section 5) or it may be a pre-printed multi-sheet carbonless form for hand entry of required information. The Chain-Of-Custody Record documents transfer of custody of samples from the sample custodian to another person, to the laboratory, or other organizational elements. The Chain-of-Custody Record will not be used to document the collection of split samples where there is a legal requirement to provide a receipt for samples (see Section 4, Receipt for Samples Form (CERCLA/RCRA/TSCA)). The Chain-Of-Custody Record also serves as a sample logging mechanism for the laboratory sample custodian. A separate Chain-of-Custody Record should be used for each final destination or laboratory used during the investigation.

All information necessary to fully and completely document the sample collection and required analyses must be recorded in the appropriate spaces to complete the field Chain-Of-Custody Record. Tag numbers are not required unless numbered "Criminal Tags" are used during an investigation. The following requirements apply to Chain-Of-Custody records generated by either the FORMS system or by hand entry on pre-printed forms:

- All sampling team leaders must sign in the designated signature block.
- One sample should be entered on each line and not be split among multiple lines.
- If multiple sampling teams are collecting samples, the sampling team leader's name should be clearly indicated for each sample.
- The total number of sample containers for each sample must be listed in the appropriate column. Required analyses should be entered in the appropriate location on the Chain-of-Custody Record.
- The field sample custodian, project leader or other designee, and subsequent transferee(s) should document the transfer of the samples listed on the Chain-of-Custody Record. Both the person relinquishing the samples and the person receiving them must sign the form. The date and time that this occurs should be documented in the proper space on the Chain-of-Custody Record. The exception to this requirement would be when packaged samples are shipped with a common carrier. Even though the common carrier accepts the samples for shipment, they do not sign the Chain-of-Custody Record as having received the samples.
- The last person receiving the samples or evidence will be the laboratory sample custodian or their designee(s).

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The Chain-of-Custody Record is a uniquely identified document. Once the Record is completed, it becomes an accountable document and must be maintained in the project file. The suitability of any other form for chain-of-custody should be evaluated based upon its inclusion of all of the above information in a legible format.

If chain-of-custody is required for documents received during investigations, the documents should be placed in large envelopes, and the contents should be noted on the envelope. The envelope will be sealed and an EPA custody seal placed on the envelope such that it cannot be opened without breaking the seal. A Chain-Of-Custody Record will be maintained for the envelope. Any time the EPA seal is broken, that fact will be noted on the Chain-Of-Custody Record and a new seal affixed, as previously described in this section.

Physical evidence such as video tapes or other small items will be placed in an evidence bag or envelope and an EPA custody seal should be affixed so that they cannot be opened without breaking the seal. A Chain-Of-Custody Record will be maintained for these items. Any time the EPA seal is broken, that fact will be noted on the Chain-of-Custody Record and a new seal affixed.

EPA custody seals can be used to maintain custody of other items when necessary by using similar procedures as those previously outlined in this section.

Samples should not be accepted from other sources unless the sample collection procedures used are known to be acceptable, can be documented, and the sample chain-of-custody can be established. If such samples are accepted, a standard sample label containing all relevant information and the Chain-Of-Custody Record will be completed for each set of samples.

3.4 Transfer of Custody with Shipment

Transfer of custody is accomplished by the following:

- Samples will be properly packaged for shipment in accordance with the procedures outlined in SESD Operating Procedure for Packing, Marking, Labeling and Shipping of Environmental and Waste Samples (SESDPROC-209).

- All samples will be accompanied by the laboratory copy of the Chain-Of-Custody Record. If pre-printed forms are used, the white and pink sheets will be sent. If FORMs is used to generate the Chain-Of-Custody Record, the laboratory copy is identified with an “L” in the upper right corner. If multiple coolers are needed for shipment to a particular laboratory, the laboratory copy of the Chain-Of-Custody Record for the entire shipment is placed in a sealed plastic bag in one of the coolers. When shipping samples via common carrier, the "Relinquished By" box should be filled in; however, the "Received By" box should be left blank. The laboratory sample custodian is responsible for receiving custody of the samples and will fill in the "Received By" section of the Chain-of-Custody Record. One

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copy of the Record will be provided to and retained by the project leader. After samples have been received and accepted by the laboratory, a copy of the Chain-of-Custody Record, with ASB sample identification numbers, will be transmitted to the project leader. This copy will become a part of the project file.

- If sent by mail, the package will be registered with return receipt requested. If sent by common carrier, an Air Bill should be used. Receipts from post offices and Air Bills will be retained as part of the documentation of the chain-of-custody. The Air Bill number or registered mail serial number will be recorded in the remarks section of the Chain-Of-Custody Record.

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4 Receipt for Samples Form (CERCLA/RCRA/TSCA)

4.1 Introduction

Section 3007 of the Resource Conservation and Recovery Act (RCRA) of 1976 and Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) of 1980 require that a "receipt" for all facility samples collected during inspections and investigations be given to the owner/operator of each facility before the field investigator departs the premises. The Toxic Substances Control Act (TSCA) contains similar provisions. The laws do not require that homeowners or other off-site property owners be given this form.

4.2 Receipt for Samples Form

A Receipt for Samples form, using either the pre-printed form or one generated by the FORMS system, is to be used to satisfy the receipt for samples provisions of RCRA, CERCLA, and TSCA. The form also documents that split samples were offered and either "Received" or "Declined" by the owner/operator of the facility or site being investigated (if a sample is split with a facility, state regulatory agency, or other party representative, the recipient should be provided (if enough sample is available) with an equal weight or volume of sample). All information must be supplied in the indicated spaces to complete the Receipt for Samples form.

- The sampler(s) must sign the form in the indicated location

- Each sample collected from the facility or site must be documented in the sample record portion of the form. The sample station number, date and time of sample collection, composite or grab sample designation, whether or not split samples were collected (yes or no should be entered under the split sample column), a brief description of each sampling location, and the total number of sample containers for each sample must be entered.

- The bottom of the form is used to document the site operator's acceptance or rejection of split samples. The project leader must sign and complete the information in the "Split Samples Transferred By" section (date and time must be entered). If split samples were not collected, the project leader should initial and place a single line through "Split Samples Transferred By" in this section. The operator of the site must indicate whether split samples were received or declined and sign the form. The operator must give their title, telephone number, and the date and time they signed the form. If the operator refuses to sign the form, the sampler(s) should note this fact in the operator's signature block and initial this entry.

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The Receipt for Samples form is an accountable document after it is completed. A copy of the form is to be given to the facility or site owner/operator. The original form must be maintained in the project files.

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5 FORMS

The container labels and the Chain-of-Custody record should be generated using the FORMS computer program, a computer program designed to streamline the documentation required by SESD and/or the Contract Laboratory Program (CLP) for sample identification and chain-of-custody. When possible, FORMS should be used during all field investigations. Once the appropriate information is entered into the computer, FORMS will generate stick-on labels for the sample containers and will generate sample receipt forms and chain-of-custody records for the appropriate laboratory. The advantages to this system include faster processing of samples and increased accuracy. Accuracy is increased because the information is entered only once, and consequently, consistent for the bottle labels, sample receipt forms and chain-of-custody records. Operating instructions are available for use with the FORMS program.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Logbooks**

Effective Date: October 8, 2010	**Number:** SESDPROC-010-R4

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESCPROC-010-R4, *Logbooks*, replaces SESDPROC-010-R3 **Title Page:** Changed the following: Author and Field Quality Manager from Laura Ackerman to Liza Montalvo; and Enforcement and Investigations Branch Chief from Antonio Quinones to Archie Lee. **Revision History:** Added statement regarding purpose of the revision history. **Section 1.2:** Added the following statement: Mention of trade names or commercial products does not constitute endorsement or recommendation for use. **Section 1.3:** Omitted reference to the H: drive. Changed the Field Quality Manager to the Document Control Coordinator. Sections 2.2 and 2.3: Section 2.3 was incorporated into Section 2.2 and Section 2.2 was re-arranged for clarity. In bullet 2 of Section 2.2, added a statement regarding photocopying requirements for penciled entries. In bullet 7, removed the requirement for signing the lined-through entry when correcting errors. Section 2.3: Former Section 2.4. Under the required information to be included in the logbook for sample collection and field measurements, added applicable SESD operating procedures and station identification.	October 8, 2010
SESCPROC-010-R3, *Logbooks*, replaces SESDPROC-010-R2 This revision reflects the following changes: **General:** Updated referenced procedures to reflect most recent version. **Title Page:** Changed title for Antonio Quinones from Environmental Investigation Branch to Enforcement and Investigations Branch **Section 1.4** Alphabetized.	November 1, 2007

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SESCPROC-010-R2, *Logbooks*, Replaces SESDPROC-010-R1 **General** The revision history in SESDPROC-010-R1 was incorporated using a hyperlink. In SESDPROC-010-R2, the hyperlink was removed and the revision history was incorporated into the document.	September 25, 2007
SESDPROC-010-R1, *Logbooks*, Replaces *Field Records (Logbooks)* SESDPROC-010-R0 This revision reflects the following changes: **General** Deleted all references to the SOSA. **Cover Page** Author was changed from Daniel Thoman to Laura Ackerman due to extensive re-writes by Laura Ackerman. Changed name of procedure from *Field Records (Logbooks)* to *Logbooks* **Section 1.1** Deleted last two sentences of first paragraph and first sentence of second paragraph for clarity. Changed examiner/analyst to field investigator. **Section 1.2** Deleted second sentence. **Section 1.3** Updated to reflect that the official copy of the procedure resides on the H: drive rather than with the FQM. **Section 2.1** Deleted first paragraph for clarity. Reworded second sentence in second paragraph and deleted third sentence in second paragraph. Deleted second and third sentences in third paragraph. Added first and last sentences of third paragraph. **Section 2.2** Deleted "Ideally" at beginning of first paragraph. Added second and third sentences in first paragraph. Added requirement for drawing a diagonal line and initialing at the end of unfilled pages. Reworded fourth sentence. Added last sentence of first paragraph. Deleted second paragraph. Added "or signing" in third paragraph. Added requirement for downloading logged data while in the field. Added requirement for indicating end of project notes in the logbooks. Added requirement for signing across adhesive labels onto logbook page if applicable. **Section 2.3** Renamed Section 2.3. Added all text in Section 2.3.	August 10, 2007

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Section 2.4 Reformatted bulleted list into separate subsections (2.4.1, 2.4.2, 2.4.3, and 2.4.4). Added "full name and initials" to items 5 and 6 in Section 2.4.1. Added items 3 – 8 and 14 in Section 2.4.3.	
SESDPROC-010-R0, Field Records (Logbooks), Original Issue	February 5, 2007

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1 General Information

1.1 Purpose

This procedure is to be used by field investigators when documenting pertinent and factual information in logbooks related to field investigations involving sampling and measurement procedures and/or other data collection events.

1.2 Scope/Application

This document describes the various types of information that should be included in the field log books used to document field investigations conducted by SESD. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

The procedures found within this document were prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

USEPA Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), November 2001

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2 Field Records and Documentation Procedures

2.1 General

Dedicated logbooks will be used for all projects and by each sampling team associated with a project. Logbook entries should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. All aspects of sample collection and handling, as well as visual observations, should be documented.

Any deviations from the quality assurance project plan that occur while in the field will be noted in the logbook(s). Logbook entries that may be considered privileged or confidential information will be handled in accordance with the relevant sections of SESD Operating Procedure for Control of Records (SESDPROC-002). The logbooks will be placed in the SESD project file upon transmittal of the final report to the project requestor.

2.2 Field Data Integrity and Accountability

Logbooks will be bound and each page in the logbook numbered and dated. In order to facilitate accurate and complete documentation of many field sampling and measurement activities, SESD-generated forms may be used. SESD-generated forms will be numbered using the page x of y format and bound prior to use in the field.

The following applies to logbooks and SESD-generated bound forms:

1. Observations, data, and calculations will be recorded at the time they are made.
2. Unless prohibited by weather, pens with permanent ink will be used to record all data. When weather conditions do not make it feasible to use permanent ink, entries should be made using a non-smear lead pencil (e.g., 2H or 3H). Upon returning from the field, the project leader will photocopy the penciled section of the logbook and certify, in writing, that the photocopied record is a true copy of the original logbook entry. The photocopy will be included in the project file.
3. Entries will be legible and contain pertinent, accurate and inclusive documentation of project activities.
4. Field investigators will draw a diagonal line through blank or unused portions of pages and initial to indicate the conclusion of an entry at 1) the end of all entries for each day, and 2) at the end of unfilled pages.
5. Upon completion of the field investigation, the end of project entries in the logbook and/or bound forms will be clearly indicated. This may be accomplished by noting "End" on the last page of notes and dating and initialing the notation.
6. In order to demonstrate continuity of the project and to preclude questioning of the integrity of the data collection process, pages should not be removed from bound logbooks and forms under any circumstances.

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7. Data or other information that has been entered incorrectly will be corrected by drawing a line through the incorrect entry and **initialing and dating** the lined-through entry. Under no circumstances should the incorrect material be erased, made illegible or obscured so that it cannot be read.
8. If pre-printed adhesive labels are used in logbooks or bound forms to facilitate organization of information entry, the field investigator who is responsible for taking notes will sign the label with the signature beginning on the label and ending on the page of the logbook such that the label cannot be removed without detection.

2.3 Logbook Entry Information

2.3.1 General Information Required in All Logbooks

The following information will be included either on the front cover or the first page of **all logbooks**:

1. Project name
2. Project location
3. Project identification number
4. Project leader (full name)
5. Sample team leader (full name) and initials
6. Sample team member(s) (full name) and initials

2.3.2 Information Required for Sample Collection

In addition to the information listed in Section 2.4.1, the following information will be included in all logbooks when **samples** are collected:

1. Applicable SESD Operating Procedures for field sampling
2. Date and time of collection
3. Station identification
4. Sample identification
5. Method of collection
6. Number and type of containers
7. Sample collection equipment
8. SESD equipment identification number, if applicable
9. Physical description of sample
10. Matrix sampled
11. Sample team member duties (calibration, collection, deployment, etc.)
12. Sample preservation (including ice), if applicable
13. Conditions that may adversely impact quality of samples, if applicable (rain, wind, smoke, dust, extreme temperature, etc.)
14. GPS coordinates (Non-logging GPS units), if applicable
15. Location of electronic data file backups, if applicable

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16. Monitoring of condition of ice in coolers or sampler
17. Other pertinent information.

2.3.3 Information Required for Field Measurements

In addition to the information listed in Section 2.4.1, the following information will be included in all logbooks when **measurements** are conducted:

1. Applicable SESD Operating Procedures for field measurement
2. Date and time of measurement or deployment
3. Sample identification
4. Station identification
5. Sample measurement equipment
6. SESD sample measurement equipment identification number
7. Manufacturer name, lot number and expiration date of all buffers and standards*
8. Calibration information, including before and after calibration readings*
9. Meter end check information
10. Deployment depth and total depth, if applicable
11. Pinger identification number and frequency for deployed equipment, if applicable
12. Time of retrieval for deployed equipment, if applicable
13. Physical description of matrix
14. Sample team member duties (calibration, collection, deployment, etc.)
15. Measurement values for non-logging equipment
16. GPS coordinates (non-logging GPS units), if applicable
17. Location of electronic data file backups, if applicable
18. Ambient air temperature, where applicable
19. Conditions that may adversely impact quality of measurement (Ex. temperature extremes)
20. Maintenance performed, if applicable
21. Meter malfunctions, if applicable
22. Other pertinent information

* Entry of calibration information in logbooks is only required for calibrations conducted in the field. All calibrations conducted at the Field Equipment Center or SESD laboratory will be recorded in the appropriate equipment tracking logbook.

2.3.4 Additional Information for Inclusion

The following information may be included in logbooks as appropriate:

1. Maps/sketches
2. Photographic or videographic log
3. Process diagrams

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Sampling Quality Control**

Effective Date: October 15, 2010	**Number:** SESDPROC-011-R3

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History	Effective Date
SESDPROC-011-R3, *Field Sampling Quality Control*, replaces SESDPROC-011-R2 **Cover Page:** The Enforcement and Investigations Branch Chief was changed from Antonio Quinones to Archie Lee. The FQM was changed from Laura Ackerman to Liza Montalvo. **Section 1.2:** Added the following statement: Mention of trade names or commercial products does not constitute endorsement or recommendation for use. **Section 1.3:** Omitted reference to the H: drive of the LAN. **Section 2.9**: On the first paragraph, replaced the word "will" with "should" on the two instances where "will" was mentioned. **Section 4.2, Subsection 1**: Removed volatiles from list of analyses for 1-liter amber containers. Added volatile organic compound to list of analyses for 8-oz. clear glass containers.	October 15, 2010
SESDPROC-011-R2, *Field Sampling Quality Control*, replaces SESDPROC-011-R1 **Revision History** Changed Field Quality Manager to Document Control Coordinator. **Section 1.3** Changed Field Quality Manager to Document Control Coordinator. **Section 2.6** Added item #8. **Section 4.1** Added clarifying language to item #5. **Section 4.2** Added "volatiles" to item #1. Added "Note" at end of item #1. **Section 4.4.1** Changed "quarter" to "year" in second paragraph.	January 28, 2008

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SESDPROC-011-R1, *Field Sampling Quality Control*, replaces SESDPROC-011-R0. **Section 1.3** Modified requirements for maintaining official copy of procedure. **Section 1.4** Stated that variability should be accounted for depending on the data quality objectives for the study. Added definitions for branch field equipment manager and de-ionized water. Removed definitions for representative sample, sample representativeness, accuracy, precision, and bias. **Section 2.5** Records of sample preservation, including ice, should be documented in the field log books. **Section 2.6** Added the SESD glove and bottle return policy. The glove and bottle return policy was previously in SESDPROC-108-R0, *Equipment and Supply Management*. **Section 3.3** Stated that variability samples will be collected in accordance to project DQOs. Removed definition for "major project". **Section 3.5** Added double volume requirement for SVOC/pesticide/PCB MS/MSD sample collection. **Section 4.1** Modified requirements for servicing both field and FEC organic-free water systems from quarterly to at least once per 180 days. **Section 4.2, Subsection 1** Added analytical requirements for testing of Teflon® tubing. **Section 4.2, Subsection 5** Modified Silastic® or Tygon® tubing testing requirements to state that new lot are required to be tested quarterly. **Section 4.4.2** Modified requirements that project leaders provide final report to QAO. Project Leaders will provide QA data to QAO.	October 19, 2007
SESDPROC-011-R0, *Field Sampling Quality Control*, Original Issue	February 5, 2007

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Contents

1 General Information

1.1 Purpose

This document describes procedures established to ensure the quality of SESD field sampling activities, including Field Equipment Center (FEC) operations involving preparation of sampling and support equipment for field operations. Collectively, these procedures ensure that field sampling teams are provided with equipment that is suitable for sampling use, and that field sampling is conducted using proper procedures, resulting in the collection of representative samples. Strict adherence to these procedures forms the basis for an acceptable field sampling quality assurance program.

1.2 Scope/Application

The procedures contained in this document are to be used by field investigators when collecting and handling samples in the field and when preparing sampling equipment for SESD field investigations. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 Definitions

1.4.1 Sample

A part of a larger lot, usually a volume, area, period or population.

1.4.2 Variability

The range or "distribution" of results around the mean value obtained from samples within a population. There are three types of variability which should be measured or otherwise accounted for in field sampling, depending on the data quality objectives (DQO) for the study:

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1. Temporal Variability

   Temporal variability is the range of results due to changes in contaminant concentrations over time. An example would be the range of concentrations obtained for a given parameter in wastewater samples collected at different times from an outfall where contaminant concentrations vary over time.

2. Spatial Variability

   Spatial variability is the range of results due to changes in contaminant concentrations as a function of their location. An example would be the range of concentrations obtained for a given parameter in surface soil from a site where discreet "hot spots" are present due to localized releases of contaminants on otherwise uncontaminated soil.

3. Sample Handling Variability

   Sample handling variability is the range of results due to the sample collection and handling techniques used by the sampler. This variability manifests itself as a positive bias due to errors such as unclean sampling equipment, cross contamination, etc., or a negative bias due to improper containers or sample preservation.

1.4.3 Grab Sample

An individual sample collected from a single location at a specific time or period of time. Grab samples are generally authoritative in nature.

1.4.4 Composite Sample

A sample collected over a temporal or spatial range that typically consists of a series of discrete, equal samples (or "aliquots") which are combined or "composited." A composite sample represents the average characteristics of the population under consideration. Four types of composite samples are listed below:

1. Time Composite (TC) – a sample comprised of a varying number of discrete samples or "aliquots" collected at equal time intervals during the compositing period. The TC sample is typically used to sample wastewater or streams.

2. Flow Proportional Composite (FPC) – A sample consisting of discrete samples or "aliquots" collected at a rate proportional to flow. The aliquots are collected during the compositing period by either a time-varying/constant volume (TV/CV) method ("automated flow proportioning") or a time-constant/varying volume (TC/VV) method ("manual flow proportioning"). The TV/CV method is typically used with automatic

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samplers that are paced by a flow meter. The TC/VV method is a manual method that individually proportions a series of discretely collected aliquots. The FPC is typically used when sampling wastewater.

3. Areal Composite – a sample composited from individual, equal aliquots collected on an areal or horizontal cross-sectional basis. Each aliquot is collected in an identical manner. Examples include sediment composites from quarter-point sampling of streams and soil samples from within grids.

4. Vertical Composite – a sample composited from individual, equal aliquots collected from a vertical cross section. Each aliquot is collected in an identical manner. Examples include vertical profiles of soil/sediment columns, lakes, and estuaries.

1.4.5 De-ionized Water

Tap water that has been treated by passing it through a standard de-ionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard Inductively Coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan. De-ionized water obtained by other methods is acceptable, as long as it meets the above analytical criteria. Organic-free water may be substituted for de-ionized water.

1.4.6 Branch Field Equipment Manager

Staff, designated by management, who are responsible for ensuring that the procedures for Equipment Inventory and Management are followed. At least one Branch Field Equipment Manager (BFEM) will be designated for the Enforcement and Investigations Branch (EIB) and the Ecological Assessment Branch (EAB).

1.5 References

SESD Safety, Health and Environmental Management Program (SHEMP) Manual, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005-most recent version)

SESD Operating Procedure for Competency and Proficiency Testing, (SESDPROC-006, most recent version)

SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108-most recent version)

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SESD Operating Procedure for Sediment Sampling (SESDPROC-200-most recent version)

SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205-most recent version)

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206-most recent version)

SESD Operating Procedure for Soil Sampling (SESDPROC-300-most recent version)

SESD Operating Procedure for Waste Sampling (SESDPROC-302-most recent version)

USEPA Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), November 2001

USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version

Loan-In Form (SESDFORM-011, most recent version)

SESD Operating Procedure for Packing, Marking, Labeling, and Shipping of Environmental and Waste Samples (SESDPROC-209, most recent version)

SESD Operating Procedure for Training (SESDPROC-007, most recent version)

SESD Operating Procedure for Corrective Action (SESDPROC-009, most recent version)

SESD Guidance for Design and Installation of Monitoring Wells (SESDGUID-101, most recent version)

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2 Field Sampling Quality Control Considerations

This section provides guidelines for establishing quality control procedures for sampling activities. Strict adherence to all of the standard operating procedures outlined in this subsection forms the basis for an acceptable sampling quality assurance program.

2.1 Experience Requirements

There is no substitute for field experience. This field experience will be gained by on-the-job training using the "buddy" system. Each new investigator will accompany an experienced employee on as many different types of field studies as possible. During this training period, the new employee will be permitted to perform all facets of field investigations, including sampling, under the direction and supervision of senior investigators. Specific requirements covering experience, competency and proficiency are found in the SESD Operating Procedure for Competency and Proficiency Testing (SESDPROC-006) and SESD Operating Procedure for Training (SESDPROC-007).

2.2 Traceability Requirements

All sample collection and measurement activities will be traceable through field records to the person collecting the sample or making the measurement. All maintenance and calibration records for sampling and measurement equipment (where appropriate) will be kept so that they are similarly traceable. The SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108) contain specific procedures to be followed that ensure traceability.

2.3 Chain-of-Custody

Specific chain-of-custody procedures are included in SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005). These procedures will ensure that evidence collected during an investigation will withstand scrutiny during litigation. To assure that procedures are being followed, it is recommended that field investigators or their designees audit chain-of-custody entries, tags or labels, field notes, and any other recorded information for accuracy. Additionally, the SESD FQM will randomly conduct reviews of project files to ensure that quality procedures are being followed.

2.4 Sampling Equipment Construction Material

Sampling equipment construction materials can affect sample analytical results. Field investigators will ensure the sample equipment construction material will not introduce contaminants to the sample being collected.

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2.5 Sample Preservation

Samples for some analyses must be preserved in order to maintain their integrity. Preservatives required for routine analyses of samples collected are found in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM). All chemical preservatives used will be supplied by the Region 4 laboratory. All samples requiring preservation should be preserved immediately upon collection in the field. Records of sample preservation, including ice, will be documented in the field log books.

Samples that **should not** be preserved in the field are:

1. Those collected within a hazardous waste site that are known or thought to be highly contaminated with toxic materials which may be highly reactive. Barrel, drum, closed container, spillage, or other source samples from hazardous waste sites are not to be preserved with any chemical.

2. Those that have extremely low or high pH or samples that may generate potentially dangerous gases if they were preserved according to the ASBLOQAM.

All samples preserved with chemicals will be clearly identified by indication on the sample tag or label that the sample is preserved. If samples normally requiring preservation were not preserved, field records should clearly specify the reason. Samples shipped by air will not be preserved with nitric acid, hydrochloric acid, sodium hydroxide, or sulfuric acid in excess of the amount specified in the ASBLOQAM.

2.6 Sample Collection Precautions

In order to prevent cross-contamination during sample collection, the following precautions will be taken:

1. A clean pair of new, non-powdered, disposable latex gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come into contact with the media being sampled.

2. Sample containers for source samples or samples suspected of containing high concentrations of contaminants will be placed in separate plastic bags immediately after collecting, tagging, etc.

3. If possible, environmental (low concentration) samples and source or waste samples (high concentration) should be collected by different field teams. If different field teams cannot be used, all environmental samples should be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated samples should never be placed in the same ice

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chest as environmental samples. Ice chests or shipping containers for source or waste samples or any samples suspected to contain high concentrations of contaminants will be lined with new, clean, plastic bags.

4. If possible, one member of the field sampling team should record all of the field notes, collect GPS data, etc., while the other members collect the samples.

5. When sampling surface water and sediment at the same location, the water sample should always be collected before the sediment sample is collected.

6. Sample collection activities should proceed progressively from the least suspected contaminated area to the most suspected contaminated area.

7. Investigators should use equipment constructed of Teflon®, stainless steel, or glass that has been properly pre-cleaned according to either the SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or the SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) for collection of samples for trace metals or organic compounds analyses. Teflon® or glass is preferred for collecting samples where trace metals are of concern. Equipment constructed of plastic or PVC should not be used to collect samples for trace organic compounds analyses.

8. Field investigators should ensure the sample containers they are using have been verified as suitable for the analyses that will be conducted on the samples through the quality control procedures discussed in Section 4 of this procedure.

Upon returning from the field, un-used sample containers will be examined by project leaders to determine whether bottles should be discarded, recycled, or re-shelved for use on other projects. A load-in form (SESDFORM-011) will be completed and signed by project leaders to identify the future use of sample containers returning from the field. Opened boxes of sampling containers that can be re-used, will be segregated from sealed boxes of new containers.

Opened bags of latex gloves returning from the field will be segregated from unopened gloves and will not be re-used for sample collection on other projects.

2.7 Sample Handling and Mixing

Once a sample has been collected, it may have to be transferred into separate containers for different analyses. Sample transfer should be done as soon as possible. If necessary, aqueous samples may be collected into a single, larger container for homogenization and transferred into individual sample containers. However, aqueous samples collected for volatile organic compounds, oil and grease, bacteria, sulfides, and phenols analyses may not be transferred using this procedure.

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It is extremely important that waste (when appropriate), soil, and sediment samples be mixed thoroughly to ensure that the sample is representative of the sample media. The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

1. The material in the sample pan should be divided into quarters and each quarter should be mixed individually.

2. Two quarters should then be mixed to form halves.

3. The two halves should be mixed to form a homogenous matrix.

This procedure should be repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over.

2.8 Special Handling of Samples for Volatile Organic Compounds Analysis

Water samples to be analyzed for volatile organic compounds should be stored in 40-ml septum vials with screw cap and Teflon®-silicone disk in the cap to prevent contamination of the sample by the cap. The disks should be placed in the caps (Teflon® side to be in contact with the sample) in the laboratory prior to the beginning of the field investigation.

The vials should be completely filled to prevent volatilization, and extreme caution should be exercised when filling a vial to avoid any turbulence which could also produce volatilization. The sample should be carefully poured down the side of the vial to minimize turbulence. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a convex meniscus. The cap is then applied and some overflow is lost, but the air space in the bottle is eliminated. After capping, turn the bottle over and tap it to check for bubbles. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

Soil and sediment samples for VOC analyses should be collected and handled as specified in the SESD Operating Procedure for Soil Sampling (SESDPROC-300), Waste Sampling (SESDPROC-302) or the SESD Operating Procedure for Sediment Sampling (SESDPROC-200). Soil and sediment samples collected for VOC analyses should <u>not</u> be mixed.

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2.9 Sample Storage and Transport

After collection, sample handling should be minimized. Field investigators should use extreme care to ensure that samples are not contaminated during storage. Environmental and waste samples are typically stored in coolers. To reduce the risk of cross contamination, smaller sample containers such as 8 ounce glass jars, 40 ml VOA vials, and one-liter amber bottles should be placed inside of sealed, plastic bags before being placed in the cooler. If ice is required for preservation of the samples, the ice should be contained in a plastic bag or some equivalent container to prevent the potential for cross contamination of the samples by water produced from melting ice. If ice is used, the coolers should be checked regularly and water should be drained as needed. Custody of samples will be maintained according to the SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005).

Samples will either be transported to the analytical laboratory by field investigators or shipped by common carrier. Shipping of samples will be conducted in accordance with the SESD Operating Procedure for Packing, Marking, labeling, and Shipping of Environmental and Waste Samples (SESDPROC-209).

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3 Quality Control Samples

Quality control samples are collected during field studies for various purposes, among which are to isolate site effects (control samples), to define background conditions (background sample), and to evaluate field/laboratory variability (spikes and blanks, trip blanks, duplicate, split samples, etc.).

3.1 Control Sample

A control sample is typically a discrete grab sample collected to isolate a source of contamination. Isolation of a source could require the collection of both an upstream sample at a location where the medium being studied is unaffected by the site being studied, as well as a downstream control which could be affected by contaminants contributed from the site under study.

3.2 Background Sample

A background sample (usually a grab sample) is collected from an area, water body, or site similar to the one being studied, but located in an area known or thought to be free from pollutants of concern.

3.3 Variability Samples

Variability may be defined as a variation in concentrations of compounds or analytes across a site or area of investigation or variations, across time, of waste streams or surface water bodies. Variation can also be introduced during sample handling. The following procedures are used to assess and evaluate variability. When appropriate, spatial duplicate grab and/or composite samples should be collected during investigations and studies in accordance to the project DQOs. In general, no more than ten percent of all samples should be collected as spatial duplicates.

3.3.1 Spatial Variability Duplicate

The following spatial duplicate sampling procedures should be used during the collection of samples as a measure of variability within the area represented by the sample. These samples should be collected at the same time, using the same procedures, the same type of equipment, and in the same types of containers as the original samples. They should also be preserved in the same manner and submitted for the same analyses as the required samples.

Spatial variability duplicate samples are typically collected during investigations where samples are collected from grids that are positioned at fixed intervals over the study area and a sample collection pattern is established within the grids. Spatial variability duplicate samples are collected using the same compositing pattern as the original sample and are collected within the same general area of representativeness, however the pattern is shifted relative to the original aliquot locations. This amount and direction of shift for the duplicate sample is

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dependent upon the size of the grid or area being sampled and should be specified in the QAPP for the investigation. Data from spatial duplicates will be examined by the investigation project leader to determine if the observed spatial variability is acceptable, based on the investigation or study objectives.

3.3.2 Temporal Variability Duplicate

When appropriate, temporal variability at a given sampling location will be measured by collecting temporal duplicate samples. These samples will be collected from the same sampling location, using the same techniques and the same type of equipment, but at a time different from the original sample. The time selected for the temporal duplicate sample will be similar to the time or span of time specified for the original sample in the project work plan. Data from temporal duplicates will be examined by the project leader to determine if samples represent the time span intended in the project work plan.

3.3.3 Sample Handling Variability

The effectiveness of sample handling techniques will be measured by collecting split and blank samples.

Split Samples

Split samples will be collected by initially collecting twice as much volume as is normally collected. The material will be apportioned, after mixing, if appropriate, into two sets of containers. Both sets of containers will be submitted for analyses with one set designated as an "original sample," the other designated as a "split sample." Data from the split samples will be examined by the project leader to assess sample handling variability. On large studies (more than 20 samples collected), a minimum of 5 percent, but no more than 10 percent, of all samples will be collected as split samples unless required by site data quality objectives.

Blank Samples

The following blank samples will be prepared by the laboratory and obtained by the project leader prior to traveling to a sample site.

1. Water Sample VOC Trip Blank - A water sample VOC trip blank is required for every study where water samples are collected for VOC analysis. Sealed preserved (or unpreserved, if unpreserved vials were used during the investigation) 40-ml VOC vials will be transported to the field. Two sealed VOC vials will be submitted per trip blank sample. At least one trip blank sample will be submitted per sample shipment. Trip blanks will be prepared by lab personnel. Investigators should submit their request for trip blanks at least one week in advance of scheduled field investigations and inspections and never (except in emergency situations) less than two days in advance of scheduled field investigations and inspections. These samples should not be picked up earlier than the morning of departure for the scheduled

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inspection/investigation. These trip blanks will be handled and treated in the same manner as the water samples collected for volatile organic compounds analysis on that particular study. These samples will be clearly identified on sample labels and Chain-of-Custody Records as trip blanks.

2. Soil/Sediment Sample VOC Trip Blank - A soil/sediment sample VOC trip blank is required for every study where soil and/or sediment samples are collected for VOC analysis. The required containers are specified the USEPA Region 4 ASBLOQAM. The request and pick up of the soil blank sample will be the same as for the water trip blank. En Core® containers will be transported to the field. These blanks will be handled and treated by field investigators in the same manner as the soil samples collected for VOC analysis on that particular study. These samples will be clearly identified on sample labels and Chain-Of-Custody Records as trip blanks. Two sealed En Core® containers will be submitted per trip blank sample. At least one set of trip blank samples will be submitted per sample shipment.

The following blanks are prepared in the field:

1. Sample Preservative Blanks - Sample containers will be filled with de-ionized water by ASB personnel and transported to the field and preserved and submitted for the same analyses as the other inorganic samples collected. These samples will be clearly identified as preservatives blanks on sample labels and the Chain-Of-Custody Record(s). At least one preservative blank for each type of preserved sample should be collected at the end of routine field investigations. In addition, one preservative blank will be collected for each bottle of preservative used.

2. Equipment Rinsate Blanks - Equipment rinsate blanks will be collected whenever field decontamination of equipment to be re-used in sampling activities is performed.

   When field cleaning of equipment is required during a sampling investigation, a piece of the field-cleaned equipment will be selected for collection of a rinse blank. At least one rinse blank will be collected during each week of sampling operations. After the piece of equipment has been field cleaned and prior to its being used for sample operations, it will be rinsed with organic-free water. The rinse water will be collected and submitted for analyses of all constituents for which normal samples collected with that piece of equipment are being analyzed.

3. Organic-Free Water System Blanks - When using a portable organic-free water generating system in the field, a sample of the water generated by the system will be collected at least once during each week of operations. Based on the objectives of the study or investigation, it may be appropriate to collect a sample of the raw source water. The collected water sample will be submitted for analyses of all constituents for which normal samples are being analyzed.

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4. Material Blanks - When construction materials are being used on a site in such a way as to have a potential impact on constituent concentrations in the sample, a sample of each material will be submitted for analysis.

   Note: For drilling operations where materials are shipped directly to the site from the supplier, see SESD Guidance for Design and Installation of Monitoring Wells (SESDGUID-101) for material blank collection and reporting requirements.

5. Automatic Sampler Blanks - In general, cleaning procedures outlined in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) should be adequate to ensure sample integrity. However, it is the standard practice of the Environmental Investigations Branch to submit automatic sampler blanks for analyses when automatic samplers are used to collect samples for organic compounds and metals analyses. Automatic sampler blanks for other standard analyses may be submitted in the event of a special investigation (e.g., criminal or civil).

6. Field Blank - A field blank is a sample that is prepared in the field to evaluate the potential for contamination of a sample by site contaminants from a source not associated with the sample collected (for example air-borne dust or organic vapors which could contaminate a soil sample). Organic-free water is taken to the field in sealed containers or generated on-site. The water is poured into the appropriate sample containers at pre-designated locations at the site. Field blanks should be collected in dusty environments and/or from areas where volatile organic contamination is present in the atmosphere and originating from a source other than the source being sampled.

7. Temperature Blank - A temperature blank is a container of water shipped with each cooler of samples requiring preservation by cooling to 6°C (ice). The temperature of the blank is measured at the time of sample receipt by the laboratory. No temperature blank is necessary for waste samples since waste samples do not require ice for preservation.

8. Wipe Sample Blank - A wipe sample blank is a sample of the material and solvent used for collecting wipe samples. The blank is handled, packaged, and transported in the same manner as all other wipe samples with the exception that it is not exposed to actual contact with the sample medium.

9. Filter Blank - When filters are used for sampling a dissolved constituent, de-ionized water should be run through at least one filter from each lot and the filtered water submitted for the same analyses. When filters are used for chlorophyll sampling, the filter should be prepared using de-ionized water and submitted for the same chlorophyll analysis.

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3.4 Spikes

Spike samples are used to measure bias due to sample handling or analytical procedures. Spike samples are typically used by SESD to evaluate the performance of contract laboratories and are shipped directly to the CLP laboratory by the ESAT contractor.

3.5 Matrix Spike/Matrix Spike Duplicate Samples for Water and Soil Samples for Organic Compounds Analyses

Matrix spike and matrix spike duplicate (MS/MSD) samples will be submitted to the laboratory for volatile organic compounds, extractable organic compounds, pesticides/PCBs and/or herbicides analyses from at least one sampling location per project and laboratory used. One MS/MSD sample should be collected per 20 samples per media collected.

Additional volume will be required for the soil MS/MSD samples. Semi-volatile organic compounds, pesticides, and PCB analyses of soil/sediment samples require the collection of one additional eight ounce glass jar. For VOC soil/sediment samples, triple volume, i.e., nine En Cores® or nine 40 ml vials with syringe collected sample, is needed for the MS/MSD samples.

Additional volume will be required for the water MS/MSD samples. For routine full scan analysis, i.e., extractable organic compounds, pesticides and PCBs, four one-liter amber containers provide the required sample volume. Eight containers, therefore, should be submitted for the MS/MSD sample. For VOC water samples, a total of six 40-ml vials should be collected.

MS/MSD samples should be collected from a location expected to be relatively free from contamination, since the samples will be used for laboratory quality control purposes. The duplicate samples should be clearly identified as "Duplicate Sample for Matrix Spike" or "MS/MSD" on the Chain-Of-Custody Record, in the field logbook and on the Contract Laboratory Program (CLP) Traffic Report Form (if appropriate). This procedure will be followed for all projects where water samples are collected for the indicated analyses. For non-routine sampling events, the Region 4 SESD laboratory should be consulted for specific sample volume and container requirements.

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3.6 Matrix Spike/Matrix Spike Duplicate Samples for Water and Soil Samples for Inorganic Analyses

A matrix spike sample and a duplicate sample (MS/MSD) will be submitted to the laboratory for inorganic analyses from at least one sampling location per project and laboratory used. One matrix spike and duplicate sample should be collected per 20 samples per media collected per laboratory.

Soil/sediment and water samples collected for inorganic analyses will normally have sufficient sample volume to perform the matrix spike analyses without requiring the collection of extra sample volume. The project leader should designate a sample, typically one considered to be representative of background or relatively uncontaminated conditions, as the matrix spike sample. For water samples, the sample volume collected will normally provide adequate volume for the MS/MSD analyses.

MS/MSD samples should be collected from a location expected to be relatively free from contamination, since the samples will be used for laboratory quality control purposes. MS/MSD samples should be clearly identified as "Duplicate Sample for Matrix Spike" or "MS/MSD" on the Chain-Of-Custody Record, in the field logbook and on the Contract Laboratory Program (CLP) Traffic Report Form (if appropriate). This procedure will be followed for all projects where water samples are collected for the indicated analyses. For non-routine sampling events, the Region 4 SESD laboratory should be consulted for specific sample volume and container requirements.

3.7 Special Quality Control Procedures for EPA Contract Laboratories

On a case-by-case basis, field investigators may be required to collect split samples (or duplicate samples if appropriate) for analyses by either the Region 4 SESD laboratory or contract laboratories. The split samples are to be submitted to the Region 4 laboratory using established procedures. The contract laboratory involved will not be notified that samples were split, i.e., there should be no indication on Chain-Of-Custody Records or CLP Traffic Report Forms submitted to the contract laboratories that these samples were split with the Region 4 SESD laboratory.

3.8 Special Quality Control Procedures for Dioxins and Furans

The Region 4 laboratory does not conduct in-house analyses for dioxins and furans. Dioxin and furans analyses are conducted by contract laboratories. The Region 4 laboratory may accept environmental samples (soil, sediment, groundwater, and surface water) suspected of being contaminated with polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF), as long as suspected PCDD and PCDF contamination is not due to RCRA hazardous waste classified as F020-023 and/or F026-028. If these environmental samples are not contaminated with an F020-023 and/or F026-028 waste, it may be analyzed for parameters other than dioxin and furans. Environmental samples known or suspected to be contaminated with the RCRA hazardous waste F020-023 and or F026-028 will not be accepted.

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NOTE: Environmental samples suspected of being contaminated with RCRA hazardous waste classified in 40 CFR, 261.31 as F032 will be accepted. The F032 waste is defined as wastewaters (except those that have not come into contact with process contaminants), process residuals, preservative drippage, and spent formulations from wood preserving processes generated at plants that currently use or have previously used chlorophenolic formulations. The F032 listing does not include K001 bottom sediment sludge from the treatment of wastewater from wood preserving processes that use creosote and or pentachlorophenol. Prior to a sampling event, the project leaders should consult with the Analytical Support Branch Sample Control Coordinator to determine if the Region 4 laboratory can accept the samples. The Region 4 SESD laboratory should also be consulted for the current quality control procedures for dioxins and furans samples prior to a sampling investigation.

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4 Internal Quality Control Procedures

The focus of this section is on Field Equipment Center (FEC) operations involving preparation of sampling and support equipment for field operations, as well as, field data generated under the specific sample collection quality control procedures discussed in Section 2. Quality control checks of these operations ensure that field sampling teams are provided with equipment that is suitable for sampling use, and that field sampling is conducted using proper procedures.

4.1 Traceability Requirements

Records, in the form of bound notebooks, will be kept by FEC personnel documenting the dates of operations and the person performing operations for the following:

1. Organic-Free Water System Maintenance (Field and FEC Systems) - Maintenance on field systems will be performed at least once per 180 days. FEC system maintenance will be performed at least once per 180 days.

2. Air Monitoring Safety Instrumentation Checkouts - Pre-loadout checks on safety monitoring instrumentation will be recorded each time they are performed. Discrepancies will be immediately reported to the Branch Safety Officer.

3. Self Contained Breathing Apparatus (SCBA) Checkouts - Pre-loadout checks on SCBAs will be recorded when they are performed. SCBA checkouts will be performed at least once per calendar quarter in the absence of loadout requests. Any discrepancies will be reported immediately to the Branch Safety Officer.

4. Other Equipment Maintenance - Maintenance performed on equipment other than that listed above will be accordance to the SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108). All required repairs will be reported to appropriate Branch Field Equipment Manager.

5. Sampling Containers and Latex Gloves - The Enforcement and Investigations Branch Quality Assurance Officer (EIB QAO) is responsible for conducting verification sampling for sample containers and latex gloves that are used during field investigations. Upon receipt, the containers and gloves are placed in the quarantine room at the FEC. A record is kept of the lot numbers for each shipment received. The EIB QAO will collect blank samples from containers and gloves within each lot received and will review the results to ensure the sample containers and gloves are suitable for use during field investigations. Once the supplies are deemed suitable, the EIB QAO will release the items for use. All equipment cleaned and wrapped for field use will be marked with the date on which preparation was completed. Equipment will be stored at the FEC in specified areas to minimize the risk of contamination while awaiting use.

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4.2 Specific Quality Control Checks

When collecting samples during field investigations, it is necessary to take measures to prevent cross contamination to ensure the integrity of the data generated. The field branches conduct verification sampling of sample containers, gloves, sampling equipment, tubing and water utilized during field investigations as one of these measures. At least once per calendar quarter, the EIB QAO will conduct the following checks and issue a written report to the EIB Branch Chief and Field Quality Manager with the results.

1. Collect and submit for analyses samples of each new lot of containers and Teflon tubing received during that quarter. Rinse blanks will be collected through the Teflon tubing. Bottles from each lot will be tagged and sealed, then submitted for the following analyses:

    1. 1-liter Amber – extractable organics, pesticides, and PCBs.

    2. 8-oz. Clear Glass – metals, cyanide, extractable organics, pesticides, PCBs, and volatile organic compounds.

    3. 1-Liter Polyethylene – metals and cyanide.

    4. Teflon tubing – metals, cyanide, extractable organics, volatile organic compounds, pesticides, and PCBs.

    NOTE: In addition to the quality control checks listed above, samples may be collected during field investigations for classical inorganic parameters such as nitrates, nitrites, sulfides, etc. Due to the detection levels generally required for these parameters, it is unlikely that cross contamination may occur in association with the sample containers and sampling equipment used during sample collection. Therefore, classical inorganic analyses are not conducted as part of the routine quality control checks. If the data quality objectives require additional quality control checks, bottles will be submitted to the laboratory for analyses.

2. Collect and submit for analyses a rinsate blank for each new lot of latex gloves received during the calendar quarter. Samples will be collected as rinse blanks using organic-free water. The rinsate will be submitted for analyses of VOCs, metals, cyanide, extractable organics, pesticides, and PCBs. A new glove will be rinsed for each parameter (e.g., one glove for the VOC sample, another glove for metals, etc.) to avoid dilution of potential contaminants on the gloves.

3. Collect and submit for analyses a sample of water from the FEC organic-free water system. The sample will be submitted for analyses of VOCs, metals, cyanide, extractable organics, pesticides, and PCBs.

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4. Collect and submit for analyses a rinsate blank of at least one piece of sampling or sample related equipment stored at the FEC. The sample will submitted for analyses of VOCs, metals, cyanide, extractable organics, pesticides, and PCBs.

5. Collect and submit for analyses a rinsate blank for each new lot of Silastic® or Tygon® tubing used in peristaltic pump head. The sample will be submitted for metals and cyanide analysis.

4.3 Quality Control for Special Order Equipment and Supplies

Some equipment and supplies ordered for specific projects are received in what can be considered ready to use condition. In order to ensure the integrity of these materials, an equipment rinsate blank will be collected from at least one item in each lot. The equipment and supplies will not be used until the QAO has reviewed the analytical data for the blanks and released the items.

4.4 Quality Control Evaluation and Corrective Action

All field investigation reports will contain a clearly identified section where the results for all field generated quality control (QC) samples are discussed and reported. Quality control data review includes but is not limited to detections of organic and inorganic compounds at any concentration in quality control blanks (i.e., trip blanks, equipment rinsate blanks, portable organic-free water system blanks, etc.).

All detections of organic and inorganic compounds will be immediately reported to the appropriate branch QAO. The project leader will analyze of the results to determine if the source of contamination can be identified. If the source of contamination cannot be determined by the project leader, the branch QAO will conduct an additional review of the results to assess the source of contamination. If the source of contamination cannot be determined, the branch QAO will monitor all quality control results generated by the branch and assess the data for trends of contamination.

If it is determined by the project leader and the branch QAO that the contamination adversely impacts the data collected during the investigation, the project leader will report the results to their Section Chief and the FQM. The project leader, in consultation with management, will determine whether the impacted data are usable or should be rejected. If data are rejected, the project leader and their management will determine whether samples must be recollected.

Data reported to the FQM will be analyzed to determine if the contamination is due to non-conforming work. If it is determined by the FQM, in consultation with management, that the contamination is due to non-conforming work, a corrective action is warranted and will be selected and implemented in a timely manner. If a corrective action is required, it must be implemented and reported according to the SESD Operating Procedure for Corrective Action (SESDPROC-009). If contamination is not due to non-

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conforming field work, then the source of contamination will be identified, if possible, and documented by the FQM. If the source of contamination cannot be determined, FQM will monitor all quality control results generated by SESD and assess the data for trends of contamination.

4.4.1 Quality Assurance Reports

It is each project leader's responsibility to ensure that a copy of the quality assurance data from each field investigation report is provided to their respective branch QAO. Each branch QAO will prepare a compilation of the quality assurance field data sections from each report and forward this report to the FQM. Due to the differences in number and nature of sampling investigations conducted, the EIB QA manager will compile a quarterly report of field quality assurance data and the EAB QA manager will compile an annual report.

The FQM will prepare an annual quality assurance report based on the reports provided by the branch QAOs. This report will be distributed to all field investigators each year and will document and discuss all quality control issues or trends identified during the data review. This report will be retained by the FQM to document that QC measures have been taken, that the QC measures are appropriate, that the QC results are acceptable or, if not, that corrective actions were taken.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Sampling and Measurement Procedures and Procedure Validation**

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-012-R2, *Field Sampling and Measurement Procedures and Procedure Validation*, replaces SESDPROC-012-R1 **General:** Corrected typographical errors. **Title Page:** Changed Enforcement and Investigations Branch Chief from Antonio Quinones to Archie Lee. **Revision History:** Changed Field Quality Manager to Document Control Coordinator. **Section 1.3:** Omitted reference to the H: drive. Changed the Field Quality Manager to the Document Control Coordinator.	December 18, 2009
SESDPROC-012-R1, *Field Sampling and Measurement Procedures and Procedure Validation*, replaces SESDPROC-012-R0 **Revision History:** Changed title for Antonio Quinones from Environmental Investigation Branch to Enforcement and Investigations Branch.	November 1, 2007
SESDPROC-012-R0, Procedure Development, Revision and Validation, Original Issue	October 10, 2007

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1 General Information

1.1 Purpose

SESD field branches operating procedures are reviewed periodically, and where necessary, revised to ensure continuing suitability and conformance with applicable requirements and industry standards. Additionally, there may be the occasion where a new sampling or measurement procedure is developed internally or adapted from an existing standard or non-standard procedure. This document defines the different classes of procedures and describes the process for:

- Development and validation of new SESD procedures; and
- Development, review/validation and approval process to be followed when adopting or revising standard or non-standard procedures.

All SESD sampling and measurement procedures in use as of February 5, 2007 are considered standard procedures and do not require validation.

1.2 Scope/Application

This document applies to all standard, non-standard and SESD-developed sampling and measurement procedures.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities. The official copy of this procedure resides on the SESD Local Area Network (LAN). The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 Definitions

The following definitions apply to this operating procedure.

1.4.1 Standard Procedure

This term applies to an established environmental sampling or measurement procedure used and accepted within the environmental industry.

1.4.2 Non-Standard Procedure

A non-standard procedure is an environmental sampling or measurement procedure that is not widely used or accepted within the environmental industry.

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1.4.3 SESD-Developed Procedure

A new sampling or measurement procedure developed by the SESD field branches for internal use.

1.5 References

SESD Operating Procedure for Document Control (SESDPROC-001, most recent version)

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2 Field Sampling and Measurement Procedures

2.1 Standard Procedures

SESD field investigators use standard procedures in the course of conducting field investigations. SESD procedures are subject to periodic review and where necessary, may be revised to ensure continuing suitability and conformance with applicable industry standards and requirements. SESD procedures undergoing periodic review that are updated with minor modifications are not subject to the validation process described in Section 3 of this procedure.

New standard procedures may be adopted for use by SESD field investigators. In addition, as state-of-the-art changes and new instruments, equipment, and procedures are developed and become available, it may be appropriate for SESD to develop and publish new operating procedures for field measurement and sampling activities.

New standard procedures adopted for use by the field branches will not be subject to an extensive validation as described in Section 3 of this procedure. New standard procedures will be evaluated to the extent necessary to ensure the result provided is equivalent to a currently used procedure or consistent results are achieved. Documentation supporting the use and acceptance of standard procedures adopted after February 5, 2007 will be maintained by the Field Quality Manager.

2.2 Non-standard Procedures

When it is necessary to use a non-standard sampling or measurement procedure, the project leader will:

1. Inform the customer in writing (email or memo) that a non-standard procedure will be used;
2. Document that the customer is in agreement with the use of a non-standard procedure; and
3. Document in the project file the customer's request and the need for using a non-standard procedure (i.e., description of the project request and why it required the use of a non-standard procedure).

Non-standard procedures will be fully validated according to Section 3 of this procedure. If the non-standard procedure is not adopted into the scope of the field branches quality system prior to use, any results generated by the procedure must be clearly identified as being outside the scope of the quality system in the field investigation report.

If the field branches choose to include the non-standard procedure in the scope of their quality system, this will be done in accordance with the SESD Operating Procedure for Document Control (SESDPROC-001).

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2.3 SESD-Developed Procedures

When it is necessary for the field branches to develop procedures for their own use, it will be a planned activity and management will designate qualified personnel to develop the procedure. Management will also ensure adequate resources (time, equipment, funding, personnel, etc.) are available to aid in the development process. If a team of staff members is tasked with the procedure development, management will designate an individual to serve as the team leader. This individual will be responsible for facilitating the development process. The development process will consist of:

1. Review of relevant literature (manufacturers' documentation, scientific publications, etc.);
2. Development of an operating procedure; and
3. Validation of the procedure.

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3 Validation

3.1 General

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled. SESD will validate 1) non-standard procedures; 2) SESD developed procedures; 3) standard procedures used outside their intended scope; and 4) amplifications and modifications of standard procedures to confirm that the procedures are fit for the intended use. Validation will be as extensive as is necessary to meet the needs of the given application.

3.2 Validation Team

SESD field branches management will designate members of the validation team and ensure adequate resources are available to complete the validation. Members may consist of subject matter experts (SMEs) and representatives from both field branches, as appropriate. Management will designate one team member as the team leader. The team leader will serve as the point of contact for the team and facilitate the validation process. The team will be responsible for developing a validation plan that should address, at a minimum, the objective of the validation, acceptance criteria, the level of testing necessary and peer review. The team will update the validation plan, as necessary, during the validation process.

3.3 Field Testing or Evaluation

The validation team will develop an appropriate field test or evaluation for the operating procedure. A member or members of the validation team will be present during the field test or evaluation to record information on the conditions, performance, and practicality of the proposed procedure.

3.4 Assessment

After completion of the field test or evaluation, the validation team will assess the results using the acceptance criteria established by the team in the validation plan.

3.5 Acceptance/Rejection of Operating Procedure

If the assessment indicates that the operating procedure meets the acceptance criteria, the validation team will finalize the operating procedure as written, or with modifications. If the acceptance criteria are not met, the team may continue the validation by returning to earlier steps in the validation process, as appropriate.

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3.6 Records

The validation team will document all decisions and actions. The following records will be generated during the validation process:

1. Validation plan
2. Relevant literature
3. Draft and final operating procedures
4. Results of field tests/evaluations
5. Results of the assessment

The validation team leader will be responsible for maintaining the records during the validation process. Upon completion of the validation, the records will be maintained by the Field Quality Manager.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field pH Measurement**

Effective Date: June 13, 2008	**Number:** SESDPROC-100-R2

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Revision History

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History	Effective Date
SESDPROC-100-R2, *Field pH Measurement*, Replaces SESDPROC-100-R1 **Cover Page:** Author was changed from Marty Allen to Ron Phelps. **Revision History** Changed Field Quality Manager to Document Control Coordinator. **Section 1.3** Changed Field Quality Manager to Document Control Coordinator. **Section 2** Added requirements for unattended deployment of in-situ monitoring equipment. **Section 3.1 and 3.2, 4** Clarified requirements for routine and NPDES compliance monitoring. **Section 3.2, 2 and 5** Added first sentence for clarification.	June 13, 2008
SESDPROC-100-R1, *Field pH Measurement*, replaces SESDPROC-100-R0 **General** Deleted all references to SOSA. Updated referenced procedures due to changes in title names and/or to reflect most recent version. Replaced “shall” with “will”. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove’s title from Acting Chief to Chief.	November 1, 2007

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Section 1.3 Updated information to reflect that procedure is located on the H: drive of the LAN. **Section 1.4** Alphabetized and revised the referencing style for consistency. **Section 2** Added last paragraph regarding stopping measurements due to environmental conditions. **Section 3.4** Re-phrased procedure #2 for clarity.	
SESDPROC-100-R0, Field pH Measurement, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes procedures, methods and considerations to be used and observed when conducting field pH measurements in aqueous phase environmental media, including groundwater, surface water and certain wastewaters.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when measuring the pH of aqueous phase environmental media in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section cannot be used to obtain pH measurements of the media being sampled, and that another method must be used to obtain said measurements, the variant instrument and/or measurement procedure will be documented in the field log book and subsequent investigation report, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

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1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when conducting field pH measurements. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

All field pH measurements pertinent to the sampling event should be recorded in the field log book for the event. All records, including a unique, traceable identifier for the instrument, such as a property number or serial number, should be entered according to the procedures outlined in the SESD Operating Procedure for Logbooks (SESDPROC-010) and the SESD Operating Procedure for Equipment Inventory and Management, (SESDPROC-108).

Care should be taken not to contaminate standards and samples and verify the expiration date of all standards prior to use. All meters should be calibrated, operated and maintained according to the manufacturer's specifications.

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2 Quality Control

All pH meters will be maintained and operated in accordance with the manufacturer's instructions and the SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108). Before a meter is taken to the field, it will be properly calibrated and verified, according to Section 3.2 of this procedure, to ensure it is operating properly. These calibration and verification checks will be documented and maintained in a logbook.

The ambient temperature in the immediate vicinity of the meter should be measured and recorded in the field logbook to insure the instrument is operated within the manufacturer's specified range of operating temperatures. For instruments that are deployed for in-situ measurements, the temperature of the medium being monitored should be measured and recorded in the logbook prior to deployment. *In-situ monitoring equipment may be utilized in unattended deployments where autonomous logging may preclude temperature measurement prior to deployment. Because in situ instrumentation generally has a wide range of operating temperature, the field investigator may utilize professional judgment in determining if the operating environment is suitable for unattended deployment.*

If at any time during a field investigation, it appears that the environmental conditions could jeopardize the quality of the measurement results, the measurements will be stopped. This will be documented in the field logbook.

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3 Field pH Measurement Procedures

3.1 General

pH is defined as the negative logarithm of the effective hydrogen-ion concentration. For routine work, a pH meter accurate and reproducible to within 0.2 Standard Unit (S.U.) is suitable. For NPDES compliance monitoring, the pH meter should be accurate and reproducible to within 0.1 S.U. Both meters should have a range of 0 to 14 S.U.s and be equipped with a temperature-compensation adjustment.

3.2 Instrument Calibration

The meter will be calibrated in accordance with the manufacturer's instructions prior to use. At a minimum, a two-point calibration should be conducted to ensure the accuracy of the meter. The following calibration guidelines are minimum requirements.

1. Verify the meter's internal temperature sensor (thermistor) against a National Institute of Standards and Technology (NIST) traceable thermometer and note any differences between the thermistor and the NIST-traceable thermometer in the logbook. If the temperatures do not agree within ± 4°C, the unit or probe must be repaired or replaced. Alternatively, if the meter can be used in a manual temperature compensation mode, the NIST-traceable thermometer may be used for temperature readings and the necessary corrections applied. Check and record the temperatures of the standards and the samples.

2. If the pH range of the sample is not known, the pH of the sample to be tested should be estimated either from historical data or by using a four-color pH indicator paper or equivalent. Using this information, calibrate the pH meter with the buffers that bracket the expected pH range. Buffer solutions are commonly pH 4, 7 and 10. It may be possible to configure the pH meter so that it can be standardized with buffers other than those in the default configuration.

3. Immerse the probe in the first buffer solution and calibrate the meter to read the correct pH. After the initial buffer calibration, calibrate the meter using other buffer solutions, as appropriate. Rinse the probe with de-ionized water and blot dry or otherwise remove excess rinse water between the different buffer solutions. Record the buffer values and temperatures used to calibrate the meter.

4. Rinse the probe with de-ionized water, blot dry or otherwise remove excess rinse water and immerse it into the original buffer and read as a sample. If the meter reads within ± 0.2 S.U. of the known value of the buffer (for general applications such as ecological studies) or ± 0.1 S.U.

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(for regulatory applications such as NPDES or drinking Water programs), record the value indicated by the meter. If the meter is outside of the acceptable accuracy range, it should be recalibrated. If it is still outside of the acceptable accuracy range after the second calibration, the electrode and/or meter should be replaced.

5. Once the meter has been properly calibrated and verified (steps 1-4 above), it is ready for use. Rinse the probe with de-ionized water and store it in the manufacturer's recommended storage solution. Leave the meter on until all sample measurements are performed and the results are recorded. When collecting measurements from grab samples, it is recommended that the meter be checked periodically against the known buffer values if used for extended periods (> 4 hrs).

6. Unless the manufacturer indicates that the meter maintains its calibration after being turned off, meters must be re-calibrated if they are turned off during their period of use.

3.3 Sample Measurement Procedures

These procedures should be followed when conducting field pH measurements of grab samples:

1. Collect a sample. If the meter thermistor is to be used for the temperature of record for the measurement activity, the temperature should be read as soon as the reading stabilizes and prior to measuring the pH.

   Note 1: When the pH meter response is slow, unstable, or non-reproducible, it may be necessary to check the conductivity. If the conductivity is lower than 20 to 30 µmhos/cm, it is permissible to add 1 ml of 1M potassium chloride solution per 100 ml of sample to improve response time for the probe. Recheck the pH and record.

   Note 2: If the pH measurements are to be used for RCRA regulatory purposes and when the pH approaches the alkaline end (pH ≥ 11.0) of the scale, the pH measurements should be made by a qualified analyst using laboratory quality equipment to control the sample at 25°C ± 1°C.

2. Immerse the probe in the sample keeping it away from the sides and bottom of the sample container. Allow ample time for the probe to equilibrate with the sample.

3. While suspending the probe away from the sides and bottom of the sample container, record the pH.

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4. Rinse the probe with de-ionized water and store it in the manufacturer's recommended storage solution until the next sample is ready.

These procedures should be followed when conducting in-situ field pH measurements:

1. Place the probe into the media to be measured and allow the pH and temperature readings to stabilize. Once the readings have stabilized, record the measurements in the logbook.

2. When deploying meters for extended periods of time, insure the measurement location is representative of average media conditions.

3.4 Operational Check

Even though it is not necessary to re-calibrate pH meters at regular intervals during the day, it is advisable to occasionally perform operational checks to determine if site conditions, such as an increase in temperature, have affected the electronics or other factors have caused the meter's performance to change or deteriorate during its period of operation. The following procedures should be followed to ensure that the performance of the meter has not changed:

1. While in use, periodically check the pH by rinsing the probe with de-ionized water, blot dry or otherwise remove excess rinse water and immerse it into the pH 7 buffer solution. If the measured pH differs by ≥ 0.2 S.U. or 0.1 S.U. (depending on the application) from the buffer solution, the meter must be re-calibrated.

2. A post-operation instrument verification check will be performed using the appropriate buffers at the end of the day or after all measurements have been taken for a particular period of operation. These measurements must be recorded in the field log book.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

GUIDANCE

Title: **Design and Installation of Monitoring Wells**

Effective Date: February 18, 2008 | **Number:** SESDGUID-101-R0

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SESDGUID-101-R0, *Design and Installation of Monitoring Wells*, Original Issue	February 18, 2008

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when designing and installing permanent and temporary groundwater monitoring wells to be used for collection of groundwater samples.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when designing, constructing and installing groundwater monitoring wells. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used for any aspect of the design, construction and/or installation of a groundwater monitoring well, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring it's use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

USEPA Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), November 2001

USEPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Science and Ecosystem Support Division, Region 4, Athens, GA.

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011-Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205- Most Recent Version

SESD Operating Procedure for Field Records and Documentation, SESDPROC-204-Most Recent Version

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SESD Operating Procedure for Groundwater Sampling, SESDPROC-301- Most Recent Version

SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202- Most Recent Version

EPA/540/S-95/503, *Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation*

ASTM standard D5092, *Design and Installation of Ground Water Monitoring Wells in Aquifers*

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when constructing and installing groundwater monitoring wells. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy (SHEMP) Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. When using this procedure, minimize exposure to potential health hazards through the use of protective clothing, eye wear and gloves. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate. Section 2.6, Safety Procedures for Drilling Activities, contains detailed and specific safety guidelines that must be followed by Branch personnel when conducting activities related to monitoring well construction and installation.

1.5.2 Procedural Precautions

The following precautions should be considered when constructing and installing groundwater monitoring wells.

- Special care must be taken to minimize or prevent inadvertent cross-contamination between borehole locations. Equipment, tools and well materials must be cleaned and/or decontaminated according to procedures found in SESD Operating Procedure for Field Equipment Cleaning and Decontamination, (SESDPROC-205).
- All field activities are documented in a bound logbook according to the procedures found in SESD Operating Procedure for Field Records and Documentation, (SESDPROC-204).

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2 Permanent Monitoring Well Design Considerations

2.1 General

The design and installation of permanent monitoring wells involves drilling into various types of geologic formations that exhibit varying subsurface conditions. Designing and installing permanent monitoring wells in these geologic environments may require several different drilling methods and installation procedures. The selection of drilling methods and installation procedures should be based on field data collected during a hydrogeologic site investigation and/or a search of existing data. Each permanent monitoring well should be designed and installed to function properly throughout the duration of the monitoring program. When designing monitoring wells, the following should be considered:

- Short-and long-term objectives;
- Purpose of the well(s);
- Probable duration of the monitoring program;
- Contaminants likely to be monitored;
- Surface and subsurface geologic conditions;
- Properties of the aquifer(s) to be monitored;
- Well screen placement;
- General site conditions; and
- Potential site health and safety hazards.

In designing permanent monitoring wells, the most reliable, obtainable data should be utilized. Once the data have been assembled and the well design(s) completed, a drilling method(s) must be selected. The preferred drilling methods for installing monitoring wells are those that temporarily case the borehole during drilling and the construction of the well, e.g. hollow-stem augers and sonic methods. However, site conditions or project criteria may not allow using these methods. When this occurs, alternate methods should be selected that will achieve the project objectives. The following discussion of methods and procedures for designing and installing monitoring wells will cover the different aspects of selecting materials and methods, drilling boreholes, and installing monitoring devices.

2.2 Drilling Methods

The following drilling methods may be used to install environmental monitoring wells or collect samples under various subsurface conditions. In all cases the preferred methods are those that case the hole during drilling, i.e. Hollow Stem Augers (HSA) and sonic methods using an override system. Other methods may be used where specific subsurface or project criteria dictate.

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2.2.1 Hollow Stem Auger (HSA)

This type of auger consists of a hollow, steel stem or shaft with a continuous, spiraled steel flight, welded onto the exterior. A hollow auger bit, generally with carbide teeth, disturbs soil material when rotated, whereupon the spiral flights transport the cuttings to the surface. This method is best suited in soils that have a tendency to collapse when disturbed. A monitoring well can be installed inside of hollow-stem augers with little or no concern for the caving potential of the soils. If caving sands exist during monitoring well installations, a drilling rig must be used that has enough power to extract the augers from the borehole without having to rotate them. A bottom plug, trap door, or pilot bit assembly can be used at the bottom of the augers to keep out most of the soils and/or water that have a tendency to enter the bottom of the augers during drilling. Potable water (analyzed for contaminants of concern) may be poured into the augers during drilling to equalize pressure so that the inflow of formation materials will be held to a minimum. Water-tight center bits are not acceptable because they create suction when extracted from the augers. This suction forces or pulls cuttings and formation materials into the augers, defeating the purpose of the center plug. Augering without a center plug or pilot bit assembly is permitted, provided that the soil plug, formed in the bottom of the augers, is removed before sampling or installing well casings. Removing the soil plug from the augers can be accomplished by drilling and washing out the plug using a rotary bit, or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger. Bottom plugs can be used where no soil sampling is conducted during the drilling process. The bottom plug is wedged into the bottom of the auger bit and is knocked out at depth with drill pipe or the weight of the casing and screen assembly. The plug material should be compatible with the screen and casing materials. The use of wood bottom plugs is not acceptable. The type of bottom plug, trap door, or pilot bit assembly proposed for the drilling activity should be approved by a senior field geologist prior to drilling operations. Boreholes can be augered to depths of 150 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

2.2.2 Solid Stem Auger

This type of auger consists of a sealed hollow or solid stem or shaft with a continuous spiraled steel flight welded on the outside of the stem. An auger bit connected to the bottom disturbs soil material when rotated and the helical flights transport cuttings to the surface. At the desired depth the entire auger string is removed to gain access to the bottom of the borehole. This auger method is used in cohesive and semi-cohesive soils that do not have a tendency to collapse when disturbed. Boreholes can be augered to depths of 200 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

Both of the previously discussed auger methods can be used in unconsolidated soils and semi-consolidated (weathered rock) soils, but not in competent rock.

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Each method can be employed without introducing foreign materials into the borehole such as water and drilling fluids, minimizing the potential for cross contamination. Minimizing the risk of cross contamination is one of the most important factors to consider when selecting the appropriate drilling method(s) for a project.

2.2.3 Sonic Methods

These methods generally alternately advance concentric hollow drill stems using rotation in conjunction with axial vibration of the drill stem. After each stage of drill stem advancement, the inner string is removed with a core of drill cuttings while the outer 'override' string remains to hold the borehole open. The cuttings can be removed nearly intact from the inner casing for examination of the stratigraphy prior to sampling or disposal. Because there are no auger flights to increase the borehole diameter, the quantity of cuttings removed from the hole is minimized as compared to hollow stem augering. With moderate rotation, smearing of the formation materials on the borehole walls is reduced as well. This drilling method is useful in a variety of materials, from flowing sands to heavily consolidated or indurated formations.

In flowing sands, the drill casings can be filled and/or pressurized with potable water to prevent excess entry of formation materials into the drill string. The same QA/QC requirements for sampling of material introduced to the borehole apply as in other drilling methods. Because the amount of water introduced into the borehole can be significant, an approximation of the water used in the drilling process should be logged for use in estimating appropriate well development withdrawal.

Sonic drilling allows a larger diameter temporary casing to be set into a confining layer while drilling proceeds into deeper aquifers. This temporary casing is then removed during the grouting operation. In many cases this will be acceptable technique. However, the level of contamination in the upper aquifer, the importance of the lower aquifers for drinking water uses, the permeability and continuity of the confining layer, and state regulations should be taken into account when specifying this practice as opposed to permanent outer casing placed into the confining unit. Note that when using the temporary casing practice, it is critical that grout be mixed and placed properly as specified elsewhere in this section.

Because the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, particular care should be taken that the well casing is placed in the center of the drill stem while placing the filter pack. Centralizers should be used in most cases to facilitate centering, particularly in the case of deep wells with PVC casing.

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2.2.4 Rotary Methods

These methods consist of a drill pipe or drill stem coupled to a drilling bit that rotates and cuts through the soils. The cuttings produced from the rotation of the drilling bit are transported to the surface by drilling fluids which generally consist of water, drilling mud, or air. The water, drilling mud, or air are forced down through the drill pipe, and out through the bottom of the drilling bit. The cuttings are then lifted to the surface between the borehole wall and the drill pipe, (or within a concentric drill stem in reverse rotary). Except in the case of air rotary, the drilling fluid provides a hydrostatic pressure that reduces or prevents borehole collapse. When considering this method, it is important to evaluate the potential for contamination when fluids and/or air are introduced into the borehole.

Due to the introduction of the various circulating fluids, the use of rotary methods requires that the potential for contamination by these fluids be evaluated. Water and mud rotary methods present the possibility of trace contamination of halogenated compounds when municipal water supplies are used as a potable water source. Air rotary drilling can introduce contamination through the use of lubricants or entrained material in the air stream. Unless contaminated formations are cased off, the circulation of drilling fluids presents a danger of cross contamination between formations. In any of the rotary (or sonic) methods, care must be exercised in the selection and use of compounds to prevent galling of drill stem threads.

2.2.4.1 Water Rotary

When using water rotary, potable water (that has been analyzed for contaminants of concern) should be used. If potable water (or a higher quality water) is not available on-site, then potable water will have to be transported to the site or an alternative drilling method will have to be selected. Water does not clog the formation materials, but the suspended drilling fines can be carried into the formation, resulting in a very difficult to develop well. This method is most appropriate for setting isolation casing.

2.2.4.2 Air Rotary

Air rotary drilling uses air as a drilling fluid to entrain cuttings and carry them to the surface. High air velocities, and consequently large air volumes and compressor horsepower are required. “Down-the-hole” (DTH) percussion hammers driven by the air stream can be used with this method to rapidly penetrate bedrock materials. Where a casing through unconsolidated material is required to prevent borehole collapse, it can be driven in conjunction with advancement of the drill stem.

When using air rotary drilling in any zone of potential contamination, the cuttings exiting the borehole must be controlled. This can be done using

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the dual-tube reverse circulation method where cuttings are carried to the surface inside dual-wall drill pipe and separated with a cyclone separator. An air diverter with hose or pipe carrying cuttings to a waste container is also an acceptable alternative. Allowing cuttings to blow uncontrolled from the borehole is not acceptable.

When using air rotary, the issue of contaminants being introduced into the borehole by the air stream must be addressed. Screw compressor systems should have a coalescing filter system in good working order to capture excess entrained compressor oils. The lubricant to be used with DTH hammers as well as thread lubricants to be used on drill stem should be evaluated for their potential impact on analytical samples.

2.2.4.3 Mud Rotary

Mud rotary is an undesirable drilling method because contamination can be introduced into the borehole from the constituents in the drilling mud, cross contamination can occur along the borehole column, and it is difficult to remove the drilling mud from the borehole after drilling and during well development. The drilling mud can also carry contaminates from a contaminated zone to an uncontaminated zone thereby cross-contaminating the borehole. If mud rotary is selected, only potable water and pure (no additives) bentonite drilling muds should be used. All materials used should have adequate documentation as to manufacturer's recommendations and product constituents. QA/QC samples of drilling muds and potable water should be sampled at a point of discharge from the circulation system to assure that pumps and piping systems are not contributing cross-contamination from previous use.

2.2.5 Other Methods

Other methods such as the cable-tool method, jetting method, and boring (bucket auger) method are available. If these and/or other methods are selected for monitoring well installations, they should be approved by a senior field geologist before field work is initiated.

2.3 Borehole Construction

2.3.1 Annular Space

The borehole or hollow stem auger should be of sufficient diameter so that well construction can proceed without major difficulties. For open boreholes, the annular space should be approximately 2" to allow the uniform deposition of well materials around the screen and riser, and to allow the passage of tremie pipes and well materials without unduly disturbing the borehole wall. For example, a 2" nominal diameter (nom.) casing would require a 6" inside diameter (ID) borehole.

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In hollow stem augers and sonic method drill casing, the ID should be of sufficient size to allow the passage of the tremie pipe to be used for well grout placement, as well as free passage of filter sands or bentonite pellets dropped through the auger or casing. In general, 4-1/4" ID should be the minimum size used for placement of 2" nom. casing and 8-1/4" ID for 4" nom. casing. Larger augers should be used where installation difficulties due to geologic conditions or greater depths are anticipated, e.g. larger augers might be required to place a bentonite pellet seal through a long water column.

2.3.2 Over-drilling the Borehole

Sometimes it is necessary to over-drill the borehole in anticipation of material entering the augers during center bit removal or knocking out of the bottom plug. Normally, 3 to 5 feet is sufficient for over-drilling. The borehole can also be over-drilled to allow for an extra space or a "sump" area below the well screen. This "sump" area provides a space to attach a 5 or 10 foot section of well casing to the bottom of the well screen. The extra space or "sump" below the well screen serves as a catch basin or storage area for sediment that flows into the well and drops out of suspension. These "sumps" are added to the well screens when the wells are screened in aquifers that are naturally turbid and will not yield clear formation water (free of visible sediment) even after extensive development. The sediment can then be periodically pumped out of the "sump" preventing the well screen from clogging or "silting up". If the borehole is inadvertently drilled deeper than desired, it can be backfilled to the design depth with bentonite pellets, chips, or the filter sand that is to be used for the filter pack.

2.3.3 Filter Pack Placement

When placing the filter pack into the borehole, a minimum of 6-inches of the filter pack material should be placed under the bottom of the well screen to provide a firm base. Also, the filter pack should extend a minimum of 2-feet above the top of the well screen to allow for settling and to isolate the screened interval from the grouting material. In open boreholes, the filter pack should be placed by the tremie or positive displacement method. Placing the filter pack by pouring the sand into an open drill stem is acceptable with the use hollow stem augers, and other methods where the borehole is temporarily cased down to the filter pack.

2.3.4 Filter Pack Seal – Bentonite Pellet Seal (Plug)

Bentonite pellets consist of ground, dried bentonite compacted into pellets available in several sizes. Bentonite pellets are compressed to a bulk density of 70-80 lbs/cu.ft. and hydrate to a 30% min. solids material. Where neat cement grouts are to be used, the placement of a bentonite pellet seal above the filter pack is mandatory to prevent the possibility of grout infiltration into the screened interval prior to setting. Bentonite chips or other sealing products should not be

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substituted in this application. Where bentonite grouts are to be used, the placement of a bentonite pellet seal is optional, but desirable.

Since bentonite pellets begin hydrating rapidly, they can be very difficult to place properly. They are generally placed by pouring slowly into open boreholes, hollow stem augers or sonic drill pipe. In some cases, pellets are placed by tremie pipe and flushed into place with potable water. A tamper can be used to ensure that the material is being placed properly and to rapidly break up any pellet bridging that occurs.

Pellet seals should be designed for a two-foot thickness of dry pellets above the filter pack. Hydration may extend the height of the seal. Where neat cement grouts are to be used, the pellets should be hydrated for eight hours, or the manufacturer's recommended hydration time, whichever is greater. Where the water table is temporarily below the pellet seal, potable (or higher quality) water should be added repeatedly to hydrate the pellets prior to grouting.

2.3.5 Grouting the Annular Space

The annular space between the casing and the borehole wall should be filled with either a 30% solids bentonite grout, a neat cement grout, or a cement/bentonite grout. Each type of grout selected should be evaluated as to its intended use and integrity. Bentonite grouts are preferred unless the application dictates the use of another material.

Bentonite grout shall be a 30% solids pure bentonite grout. Drilling muds are not acceptable for grouting. The grout should be placed into the borehole, by the tremie method, from the top of the bentonite seal to within 2-feet of the ground surface or below the frost line, whichever is the greater depth. The bentonite pellet seal or filter pack should not be disturbed during grout placement, either by the use of a side discharge port on the tremie tube, or by maintaining clearance between the bottom of the tremie tube and the bentonite seal or filter pack. The grout should be allowed to cure for a minimum of 24 hours before the concrete surface pad is installed. The preferred method of achieving proper solids content is by measurement of ingredients per the manufacturer's specifications during mixing with a final check by grout balance after mixing. Bentonite grouts should have a minimum density of 10 lbs/gal to ensure proper gelling and low permeability. The density of the first batch of grout should be measured while mixing to verify proper measurement of ingredients. In addition, the grouting operation should not cease until the bentonite grout flowing out of the borehole has a minimum density of 10 lbs/gal. Estimating the grout density is not acceptable.

Cement grouts are generally dictated where a high level of dissolved solids or a particular dissolved constituent would prevent proper gelling of a bentonite grout. Neat cement grouts (cement without additives) should be mixed using 6 gallons of

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water per 94-lb bag of Type 1 Portland cement to a density of 15lbs/gal. The addition of bentonite (5 to 10 percent) to the cement grout can be used to delay the "setting" time and may not be needed in all applications. The specific mixtures and other types of cement and/or grout proposed should be evaluated on a case by case basis by a senior field geologist.

2.3.6 Above Ground Riser Pipe and Outer Casing

The well casing, when installed and grouted, should extend above the ground surface a minimum of 2.5 feet. A vent hole should be drilled into the top of the well casing cap to permit pressure equalization, if applicable. An outer protective casing should be installed into the borehole after the annular grout has cured for at least 24 hours. The outer protective casing should be of steel construction with a hinged, locking cap. Generally, outer protective casings used over 2-inch well casings are 4 inches square by 5 feet long. Similarly, protective casings used over 4-inch well casings are 6 inches square and 5 feet long. Other types of protective casing including those constructed of pipe are also acceptable. All protective casings should have sufficient clearance around the inner well casings, so that the outer protective casings will not come into contact with the inner well casings after installation. The protective casings should have a weep hole to allow drainage of accumulated rain or spilled purge water. The weep hole should be approximately 1/4-inch in diameter and drilled into the protective casings just above the top of the concrete surface pad to prevent water from standing inside of the protective casings. Protective casings made of aluminum or other soft metals are normally not acceptable because they are not strong enough to resist tampering. Aluminum protective casing may be used in very corrosive environments such as coastal areas.

Prior to installing the protective casing, the bentonite grout in the borehole annulus is excavated to a depth of approximately two feet. The protective casing is installed by pouring concrete into the borehole on top of the grout. The protective casing is then pushed into the wet concrete and borehole a minimum of 2 feet. Extra concrete may be needed to fill the inside of the protective casing so that the level of the concrete inside of the protective casing is at or above the level of the surface pad. In areas where frost heave of the surface pad is possible, the protective casing should first be pressed into the top surface of the bentonite grout seal and concrete poured around the protective casing. A granular material such as sand or gravel can then be used to fill the space between the riser and protective casing. The use of granular material instead of concrete between the protective casing and riser will also facilitate the future conversion of the well to a flush-mount finish, if required. The protective casing should extend above the ground surface to a height so that the top of the inner well casing is exposed when the protective casing is opened. At each site, all locks on the outer protective casings should be keyed alike.

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2.3.7 Concrete Surface Pad

A concrete surface pad should be installed around each well at the same time as the outer protective casing is being installed. The surface pad should be formed around the well casing. Concrete should be placed into the pad forms and into the borehole (on top of the grout) in one operation making a contiguous unit. The size of the concrete surface pad is dependent on the well casing size. If the well casing is 2 inches in diameter, the pad should be 3 feet x 3 feet x 4 inches. If the well casing is 4 inches in diameter, the pad should be 4 feet x 4 feet x 6 inches. Round concrete surface pads are also acceptable. The finished pad should be slightly sloped so that drainage will flow away from the protective casing and off of the pad. A minimum of one inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.

2.3.8 Surface Protection – Bumper Guards

If the monitoring wells are located in a high traffic area, a minimum of three bumper guards consisting of steel pipes 3 to 4 inches in diameter and a minimum 5-foot length should be installed. These bumper guards should be installed to a minimum depth of 2 feet below the ground surface in a concrete footing and extend a minimum of 3 feet above ground surface. Concrete should also be placed into the steel pipe to provide additional strength. Substantial steel rails and/or other steel materials can be used in place of steel pipe. Welding bars between the bumper posts can provide additional strength and protection in high traffic areas, but the protective bumpers should not be connected to the protective casing.

2.4 Construction Techniques

2.4.1 Well Installation

The borehole should be bored, drilled, or augered as close to vertical as possible, and checked with a plumb bob or level. Deviation from plumb should be within 1° per 50ft of depth. Slanted boreholes are undesirable and should be noted in the boring logs and final construction logs. The depth and volume of the borehole, including the over-drilling if applicable, should have been calculated and the appropriate materials procured prior to drilling activities.

The well casings should be secured to the well screen by flush-jointed threads and placed into the borehole and plumbed by the use of centralizers and/or a plumb bob and level. Another method of placing the well screen and casings into the borehole and plumbing them at the same time is to suspend the string of well screen and casings in the borehole by means of a hoist on the drill rig. This wireline method is especially useful if the borehole is deep and a long string of well screen and casings have to be set and plumbed.

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No lubricating oils or grease should be used on casing threads. No glue of any type should be used to secure casing joints. Teflon "O" rings can also be used to insure a tight fit and minimize leakage; however, "O" rings made of other materials are not acceptable if the well is going to be sampled for organic compound analyses.

Before the well screen and casings are placed on the bottom of the borehole, at least 6 inches of filter material should be placed at the bottom of the borehole to serve as a firm footing. The string of well screen and casings should then be placed into the borehole and plumbed. Centralizers can be used to plumb a well, but centralizers should be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. Centralizers placed in the wrong locations can cause bridging during material placement. Monitoring wells less than 50 feet deep generally do not need centralizers. If centralizers are used they should be placed below the well screen and above the bentonite pellet seal. The specific placement intervals should be decided based on site conditions.

When installing the well screen and casings through hollow-stem augers, the augers should be slowly extracted as the filter pack, bentonite pellet seal, and grout are tremied and/or poured into place. The gradual extraction of the augers will allow the materials being placed in the augers to flow out of the bottom of the augers into the borehole. If the augers are not gradually extracted, the materials (sand, pellets, etc.) will accumulate at the bottom of the augers causing potential bridging problems.

After the string of well screen and casing is plumb, the filter pack material should then be placed around the well screen to the designated depth. With cased drilling methods, the sand should be poured into the casing or augers until the lower portion is filled. The casing or augers are then withdrawn, allowing the sand to flow into the evacuated space. With hollow stem augers, sand should always fill the augers 6-12 inches, maintained by pouring the sand while checking the level with a weighted tag line. The filter pack sand in open boreholes should be installed by tremie methods, using water to wash the sand through the pipe to the point of placement.

After the filter pack has been installed, the bentonite pellet seal (if used) should be placed directly on top of the filter pack to an unhydrated thickness of two feet. When installing the seal for use with ~~neat~~ cement grouts, the bentonite pellet seal should be allowed to hydrate a minimum of eight hours or the manufacturer's recommended hydration time, whichever is longer.

After the pellet seal has hydrated for the specified time, the grout should then be pumped by the tremie method into the annular space around the casings. The grout should be allowed to set for a minimum of 24 hours before the surface pad and protective casing are installed.

After the surface pad and protective casing are installed, bumper guards should be installed (if needed). The bumper guards should be placed around the concrete surface pad in a configuration that provides maximum protection to the well. Each piece of steel pipe or approved material should be installed into an 8-to 10-inch diameter hole, to a minimum depth of 2 feet below ground surface, and filled with concrete. As previously stated, the bumper guard should extend above the ground surface a minimum of 3 feet. The total length of each bumper guard should be a minimum of 5 feet.

After the wells have been installed, the outer protective casing should be painted with a highly visible paint. The wells should be permanently marked with the well number, date installed, site name, elevation, etc., either on the cover or an appropriate place that will not be easily damaged and/or vandalized.

If the monitoring wells are installed in a high traffic area such as a parking lot, in a residential yard, or along the side of a road it may be desirable to finish the wells to the ground surface and install water-tight flush mounted traffic and/or man-hole covers. Flush mounted traffic and man-hole covers are designed to extend from the ground surface down into the concrete plug around the well casing. Although flush mounted covers may vary in design, they should have seals that make the unit water-tight when closed and secured. The flush mounted covers should be installed slightly above grade to minimize standing water and promote runoff. Permanent identification markings should be placed on the covers or in the concrete plug around the cover. Expansive sealing plugs should be used to cap the well riser to prevent infiltration of any water that might enter the flush cover.

2.4.2 Double-Cased Wells

Double-cased wells should be constructed when there is reason to believe that interconnection of two aquifers by well construction may cause cross-contamination or when flowing sands make it impossible to install a monitoring well using conventional methods. A highly contaminated surface soil zone may also be cased off so that drilling may continue below the casing with reduced danger of cross contamination. A pilot borehole should be bored through the overburden and/or the contaminated zone into the clay confining layer or bedrock. An outer casing (sometimes called surface or pilot casings) should then be placed into the borehole and sealed with grout. The borehole and outer casing should extend into tight clay a minimum of two feet and into competent bedrock a minimum of 1 foot. The total depths into the clay or bedrock will vary, depending on the plasticity of the clay and the extent of weathering and\or fracturing of the bedrock. The final depths should be approved by a senior field geologist. The size of the outer casing should be of sufficient inside diameter to contain the inner casing, and the 2-inch minimum annular space. In addition, the borehole should be of sufficient size to contain the outer casing and the 2-inch minimum outer annular space, if applicable.

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The outer casing should be grouted by the tremie, displacement, grout shoe, or Halliburton method from the bottom to the ground surface. The grout should be pumped into the annular space between the outer casing and the borehole wall. A minimum of 24 hours should be allowed for the grout plug (seal) to cure before attempting to drill through it. The grout mixture used to seal the outer annular space should be either a neat cement, cement/bentonite, cement/sand, or a 30% solids bentonite grout. However, the seal or plug at the bottom of the borehole and outer casing should consist of a Type I portland cement/bentonite or cement/sand mixture. The use of a pure bentonite grout for a bottom plug or seal is not acceptable, because the bentonite grout cures to a gel-like material, and is not rigid enough to withstand the stresses of drilling. When drilling through the seal, care should be taken to avoid cracking, shattering, or washing out the seal. If caving conditions exist so that the outer casing cannot be sufficiently sealed by grouting, the outer casing should be driven into place and a grout seal placed in the bottom of the casing.

2.4.2.1 Bedrock Wells

The installation of monitoring wells into bedrock can be accomplished in two ways:

1. The first method is to drill or bore a pilot borehole through the soil overburden into the bedrock. An outer casing is then installed into the borehole by setting it into the bedrock, and grouting it into place as described in the previous section. After the grout has set, the borehole can then be advanced through the grout seal into the bedrock. The preferred method of advancing the borehole into the bedrock is rock coring. Rock coring makes a smooth, round hole through the seal and into the bedrock without cracking and/or shattering the seal. Roller cone bits are used in soft bedrock, but extreme caution should be taken when using a roller cone bit to advance through the grout seal in the bottom of the borehole because excessive water and "down" pressure can cause cracking, eroding (washing), and/or shattering of the seal. Low volume air hammers may be used to advance the borehole, but they have a tendency to shatter the seal because of the hammering action. If the structural integrity of the grout seal is in question, a pressure test can be utilized to check for leaks. A visual test can also be made by examining the cement/concrete core that is collected when the seal is cored with a diamond coring bit. If the seal leaks (detected by pressure testing) and/ or the core is cracked or shattered, or if no core is recovered because of washing, excessive down pressure, etc., the seal is not acceptable. The concern over the structural integrity of the grout seal applies to all double cased wells. Any proposed method of double casing and/or seal testing will be evaluated on its own merits, and will have to be approved by a senior field geologist before and during drilling activities, if

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applicable. When the drilling is complete, the finished well will consist of an open borehole from the ground surface to the bottom of the well. There is no inner casing, and the outer surface casing, installed down into bedrock, extends above the ground surface, and also serves as the outer protective casing. If the protective casing becomes cracked or is sheared off at the ground surface, the well is open to direct contamination from the ground surface and will have to be repaired immediately or abandoned. Another limitation to the open rock well is that the entire bedrock interval serves as the monitoring zone. In this situation, it is very difficult or even impossible to monitor a specific zone, because the contaminants being monitored could be diluted to the extent of being non-detectable. The installation of open bedrock wells is generally not acceptable in the Superfund and RCRA programs, because of the uncontrolled monitoring intervals. However, some site conditions might exist, especially in cavernous limestone areas (karst topography) or in areas of highly fractured bedrock, where the installation of the filter pack and its structural integrity are questionable. Under these conditions the design of an open bedrock well may be warranted.

2. The second method of installing a monitoring well into bedrock is to install the outer surface casing and drill the borehole (by an approved method) into bedrock, and then install an inner casing and well screen with the filter pack, bentonite seal, and annular grout. The well is completed with a surface protective casing and concrete pad. This well installation method gives the flexibility of isolating the monitoring zone(s) and minimizing inter-aquifer flow. In addition, it gives structural integrity to the well, especially in unstable areas (steeply dipping shales, etc.) where the bedrock has a tendency to shift or move when disturbed. Omitting the filter pack around the well screen is a general practice in some open rock borehole installations, especially in drinking water and irrigation wells. However, without the filter pack to protect the screened interval, sediment particles from the well installation and/or from the monitoring zone could clog the well screen and/or fill the screened portion of the well rendering it inoperable. Also, the filter pack serves as a barrier between the bentonite seal and the screened interval. Rubber inflatable packers have been used to place the bentonite seal when the filter pack is omitted, but the packers have to remain in the well permanently and, over a period of time, will decompose and possibly contribute contaminants to the monitoring zone.

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2.5 Well Construction Materials

2.5.1 Introduction

Well construction materials are chosen based on the goals and objectives of the proposed monitoring program and the geologic conditions at the site(s). In this section, the different types of available materials will be discussed.

2.5.2 Well Screen and Casing Materials

When selecting the materials for well construction, the prime concern should be to select materials that will not contribute foreign constituents, or remove contaminants of concern from the ground water. If the monitoring program is designed to analyze for organic compounds, stainless steel materials are the preferred choice. If the monitoring program calls for the analyses of only inorganic compounds or the contaminants or formation are highly corrosive, then rigid PVC materials meeting National Sanitary Foundation (NSF) Standard 14 type WC (Well Casing) are acceptable. PVC materials may be acceptable for monitoring identified organic compounds in a soluble aqueous phase where incompatibilities are known to not exist. EPA document EPA/540/S-95/503, *Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation* (http://www.epa.gov/ada/-download/issue/napl.pdf) should be used for guidance in this area and in the use of PVC with non-aqueous phase liquids (NAPLs). Another concern is to select materials that will be rugged enough to endure the entire monitoring period. Site conditions will generally dictate the type of materials that can be used. A preliminary field investigation should be conducted to determine the geologic conditions, so that the most suitable materials can be selected. The best grade or highest quality material for that particular application should be selected. Each manufacturer can supply the qualitative data for each grade of material that is being considered. All materials selected for monitoring well installation should be evaluated and approved by a senior field geologist prior to field activities.

Well screen and casing materials generally used in monitoring well construction on RCRA and Superfund sites are listed in order of preference:

1. Stainless Steel (304 or 316)
2. Rigid PVC meeting NSF Standard 14 (type WC)
3. Other (where applicable)

There are other materials used for well screens and casings such as black iron, carbon steel, galvanized steel, and fiberglass, but these materials are not recommended for use in long term monitoring programs at hazardous waste sites, because of their low resistance to chemical attack and potential constituent contribution to the ground water. In cases where a driven casing is used, or a high strength outer casing is needed, carbon steel may be acceptable in non-corrosive aquifers. This outer casing should have threaded connections. Welding casing is

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not an acceptable practice unless all relevant safety issues have been adequately addressed.

The minimum nominal casing size for most permanent monitoring wells will be 2". Where a complete program of installation, monitoring, and abandonment is being designed, smaller wells may be installed if suitable purging and sampling equipment for the smaller diameter wells can be specified and obtained. The length of well screens in permanent monitoring wells should be long enough to effectively monitor the interval or zone of interest. However, well screens designed for long term monitoring purposes should normally not be less than 5 feet in length. Well screens less than 5 feet long are generally only used in temporary monitoring wells where ground water samples are collected for screening purposes.

2.5.3 Filter Pack Materials

The filter pack materials should consist of clean, rounded to well-rounded, hard, insoluble particles of siliceous composition. The required grain-size distribution or particle sizes of the filter pack materials should be selected based upon a sieve analysis conducted on the soil samples collected from the aquifer materials and/or the formation(s) to be monitored. Filter pack materials should not be accepted unless proper documentation can be furnished as to the composition, grain-size distribution, cleaning procedure, and chemical analysis. If a data search reveals that there is enough existing data to adequately design the well screen and filter pack, then it may not be necessary to conduct a sieve analysis on the formation materials to be monitored. However, all data and design proposals will be evaluated and approved by a senior staff geologist before field activities begin.

2.5.4 Filter Pack and Well Screen Design

The majority of monitoring wells are installed in shallow ground water aquifers that consist of silts, clays, and sands in various combinations. These shallow aquifers are not generally characteristic of aquifers used for drinking water. Therefore, modifications to the procedures used for the design of water well filter packs may be required. In cases where insufficient experience exists with local or similar materials, the filter pack and well screen design should be based on the results of a sieve analysis conducted on soil samples collected from the aquifer or the formation(s) that will be monitored.

In formations consisting primarily of fines (silts and clays), the procedures for water well screen design may result in requirements for filter packs and screen slot sizes that are not available. In those cases the selection of 0.010" screen slots with a 20-40 sand filter pack, or 0.005" screen slots with 100 sand filter pack for very fine formations, will be acceptable practice. Table 6.6.1 provides size specifications for the selection of sand packs for fine formation materials. ASTM standard D5092, *Design and Installation of Ground Water Monitoring Wells in*

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Aquifers, may be consulted for further guidance on specifications for sand appropriate for these applications.

Table 6.6.1
Sand Pack Specifications

Screen Opening (in)	Sand Pack Mesh Name	1% Passing Size (d-1) (in)	10% Passing Size (d-10) (in)	30% Passing Size (d-30) (in)	Derived 60% Passing Size (d-60) (in)	Range for Uniformity Coefficient
0.005-0.006	100	.0035 - .0047	.0055 - .0067	.0067 - .0083	.0085 - .0134	1.3 - 2.0
0.010"	20-40	.0098 - .0138	.0157 - .0197	.0197 -.0236	.020 - .0315	1.1 - 1.6

The following procedure should be used in coarser grained formations:

The data from the sieve analysis are plotted on a grain-size distribution graph, and a grain-size distribution curve is generated. From this grain-size distribution curve, the uniformity coefficient (Cu) of the aquifer material is determined. The Cu is the ratio of the 60 percent finer material (d60) to the 10 percent finer material (d10)

$$Cu = (d60/d10)$$

The Cu ratio is a way of grading or rating the uniformity of grain size. For example, a Cu of unity means that the individual grain sizes of the material are nearly all the same, while a Cu with a large number indicates a large range of particle sizes. As a general rule, a Cu of 2.5 or less should be used in designing the filter pack and well screen.

Before designing the filter pack and well screen, the following factors should be considered:

1. Select the well screen slot openings that will retain 90 percent of the filter pack material.

2. The filter pack material should be of the size that minimizes head losses through the pack and also prevents excessive sediment (sand, silt, clay) movement into the well.

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3. A filter material of varying grain sizes is not acceptable because the smaller particles fill the spaces between the larger particles thereby reducing the void spaces and increasing resistance to flow. Therefore, filter material of the same grain size and well rounded is preferred.

4. The filter pack design is based on the gradation of the finest aquifer materials being analyzed.

Steps to design a filter pack in aquifers:

1. Construct a grain-size distribution curve, on a grain-size distribution graph, from the sieve analysis of the aquifer materials. The filter pack design (as stated above) is based on the gradation of the finest aquifer materials.

2. Multiply the d30 size from the grain-size distribution graph by a factor of four to nine (Pack-Aquifer ratio). A factor of four is used if the formation is fine-grained and uniform (Cu is less than 3), six if it is coarse-grained and non-uniform, and up to nine if it is highly non-uniform and contains silt. Head losses through filter packs increase as the Pack-Aquifer (P-A) ratios decrease. In order to design a fairly stable filter pack with a minimum head loss, the d30 size should be multiplied by a factor of four.

3. Plot the point from step 2 on the d30 abscissa of a grain-size distribution graph and draw a smooth curve with a uniformity coefficient of approximately 2.5.

4. A curve for the permissible limits of the filter pack is drawn plus or minus 8 per cent of the desired curve with the Cu of 2.5.

5. Select the slot openings for the well screen that will retain 90 per cent or more of the filter pack material.

The specific steps and procedures for sieve analysis and filter pack design can be found in soil mechanics, ground water, and water well design books. The staff geologists and/or engineers should be responsible for the correct design of the monitoring wells and should be able to perform the design procedures.

2.6 Safety Procedures for Drilling Activities

A site health and safety plan should be developed and approved by the Branch Safety Officer or designee prior to any drilling activities, and should be followed during all drilling activities. The driller or designated safety person should be responsible for the safety of the drilling team performing the drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, utilities should be marked or cleared by the appropriate state

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or municipal utility protection organization. In developed areas, additional measures should be taken to locate utilities not covered by the utility protection program. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements should be adhered to while performing drilling activities:

1. All drilling personnel should wear safety hats, safety glasses, and steel toed boots. Ear plugs are required and will be provided by the safety officer or driller.

2. Work gloves (cotton, leather, etc.) should be worn when working around or while handling drilling equipment.

3. All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.

4. All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating. Rod wipers, rather than gloves or bare hands should be used to remove mud, or other material, from drill stem as it is withdrawn from the borehole.

5. Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.

6. Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.

7. Keep the drilling area clear of any excess debris, tools, or drilling equipment.

8. The driller will direct all drilling activities. No work on the rig or work on the drill site will be conducted outside of the driller's direction. Overall drill site activities will be in consultation with the site geologist or engineer, if present.

9. Each drill rig will have a first-aid kit and a fire extinguisher located on the rig in a location quickly accessible for emergencies. All drilling personnel will be familiarized with their location.

10. Work clothes will be firm fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.

11. Rings, watches, or other jewelry will not be worn while working around the drill rig.

12. The drill rig should not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig should not be operated while there is lightening in the area of the drilling site. If an electrical storm moves in during drilling activities, the area will be vacated until it is safe to return.

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2.7 Well Development

A newly completed monitoring well should not be developed for at least 24 hours after the surface pad and outer protective casing are installed. This will allow sufficient time for the well materials to cure before development procedures are initiated. The main purpose of developing new monitoring wells is to remove the residual materials remaining in the wells after installation has been completed, and to try to re-establish the natural hydraulic flow conditions of the formations which may have been disturbed by well construction, around the immediate vicinity of each well. A new monitoring well should be developed until the column of water in the well is free of visible sediment, and the pH, temperature, turbidity, and specific conductivity have stabilized. In most cases the above requirements can be satisfied; however, in some cases the pH, temperature, and specific conductivity may stabilize but the water remains turbid. In this case the well may still contain well construction materials, such as drilling mud in the form of a mud cake and/or formation soils that have not been washed out of the borehole. Excessive or thick drilling mud can not be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete the well development. If the well is pumped to dryness or near dryness, the water table should be allowed to sufficiently recover (to the static water level) before the next development period is initiated. Caution should be taken when using high rate pumps and/or large volume air compressors during well development because excessive high rate pumping and high air pressures can damage or destroy the well screen and filter pack. The onsite geologist should make the decision as to the development completion of each well. All field decisions should be documented in the field log book.

The following development procedures, listed in approximate increasing order of the energy applied to the formation materials, are generally used to develop wells:

1. Bailing
2. Pumping/overpumping
3. Surging
4. Backwashing ("rawhiding")
5. Jetting
6. Compressed air (with appropriate filtering): airlift pumping and air surging

These development procedures can be used, individually or in combination, in order to achieve the most effective well development. In most cases, over-pumping and surging will adequately develop the well without imparting undue forces on the formation or well materials. Except when compressed air is being used for well development, sampling can be initiated as soon as the ground water has re-equilibrated, is free of visible sediment, and the water quality parameters have stabilized. Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24 hours after development to sample a new monitoring well. Wells developed with stressful measures may require as long as a 7-day interval before sampling. In particular, air surge developed wells require 48 hours or longer after development so that the formation can dispel the compressed air and re-

stabilize to pre-well construction conditions. Because of the danger of introducing contaminants with the airstream, the possibility of entraining air in the aquifer, and the violent forces imparted to the formation, air surging is the least desired method of development and should only be used where there is a specific need for the procedure. Air-lift pumping is permissible where an eductor pipe is used and several well volumes of water are removed from the well by other by pumping means after air-lift pumping. The selected development method(s) should be approved by a senior field geologist before any well installation activities are initiated.

2.8 Well Decommisioning (Abandonment)

When a decision is made to decommission (abandon) a monitoring well, the borehole should be sealed in such a manner that the well can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly decommission a well, the preferred method is to completely remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete. In order to comply with state well decommissioning requirements, the appropriate state agency should be notified (if applicable) of monitoring well decommissioning. However, some state requirements are not explicit, so a technically sound well abandonment method should be designed based on the site geology, well casing materials, and general condition of the well(s).

2.8.1 Decommissioning Procedures

As previously stated the preferred method should be to completely remove the well casing and screen from the borehole. This may be accomplished by augering with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing should then be removed from the hole with the drill rig. The clean borehole can then be backfilled with the appropriate grout material. The backfill material should be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). This abandonment method can be accomplished on small diameter (1-inch to 4-inch) wells without too much difficulty. With wells having 6-inch or larger diameters, the use of hollow-stem augers for casing removal is very difficult or almost impossible. Instead of trying to ream the borehole with a hollow-stem auger, it is more practical to force a drill stem with a tapered wedge assembly or a solid-stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space and/or sound well casings can be removed in this manner. However, old wells with badly corroded casings and/or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case should be to pressure grout the borehole by placing the tremie tube to the bottom of the well casing, which will be the well screen or the bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter material and up the inside of the well casing sealing holes and breaks that are present.

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A PVC well casing may be more difficult to remove from the borehole than a metal casing, because of its brittleness. If the PVC well casing breaks during removal, the borehole should be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by water or drilling mud. Another method is to use a solid-stem auger with a carbide tooth pilot bit to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole should be cleaned out and pressure grouted with the approved grouting materials.

Where state regulations and conditions permit, it may be permissible to grout the casing in place. This decision should be based on confidence in the original well construction practice, protection of drinking water aquifers, and anticipated future property uses. The pad should be demolished and the area around the casing excavated. The casing should be sawn off at a depth of three feet below ground surface. The screen and riser should be tremie grouted with a 30% solids bentonite grout in the saturated zone. The remaining riser may be grouted with a cement grout for long term resistance to dessication.

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3 Temporary Monitoring Well Installation

3.1 Introduction

Five types of temporary monitoring well installation techniques have been demonstrated as acceptable. The type selected for a particular site is dependent upon site conditions. The project leader and site geologist should be prepared to test temporary well installations on site and select the best solution. Temporary wells are cost effective, may be installed quickly, and provide a synoptic picture of ground water quality.

Temporary monitoring well locations are not permanently marked, nor are their elevations normally determined. Sand pack materials may or may not be used, but typically there is no bentonite seal, grout, surface completion, or extensive development (as it normally applies to permanent monitoring wells). Temporary wells are generally installed, purged, sampled, removed, and backfilled in a matter of hours.

Due to the nature of construction, turbidity levels may initially be high. However, these levels may be reduced by low flow purging and sampling techniques as described in Section 7.2.4.

Temporary wells may be left overnight, for sampling the following day, but the well must be secured, both against tampering and against the fall hazard of the open annulus. If the well is not sampled immediately after construction, the well should be purged prior to sampling as specified in SESD Operating Procedure for Groundwater Sampling, SESDPROC-301.

3.2 Data Limitation

Temporary wells described in this section are best used for delineation of contaminant plumes at a point in time, and for some site screening purposes. They are not intended to replace permanent monitoring wells. Temporary wells can be used in conjunction with a mobile laboratory, where quick analytical results can be used to delineate contaminant plumes.

3.3 Temporary Well Materials

Materials used in construction of temporary monitoring wells are the same standard materials used in the construction of permanent monitoring wells. Sand used for the filter pack (if any) should be as specified in Section 2.5.3, Filter Pack Materials. The well screen and casing should be stainless steel for ruggedness and suitability for steam cleaning and solvent rinsing. Other materials may be acceptable, on a case by case basis. Some commercially available temporary well materials, pre-packed riser, screen and filter pack assemblies are available commercially; however, these pre-assembled materials cannot be cleaned. Appropriate QA/QC must be performed to assure there will be no introduction of contamination.

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3.4 Temporary Monitoring Well Borehole Construction

Borehole construction for temporary wells is as specified in Section 2.3, using a drill rig. Alternatively, boreholes may be constructed using hand augers or portable powered augers (generally limited to depths of ten feet or less). If a drill rig is used to advance the borehole, the augers must be pulled back the length of the well screen (or removed completely) prior to sampling. When hand augers are used, the borehole is advanced to the desired depth (or to the point where borehole collapse occurs). In situations where borehole collapse occurs, the auger bucket is typically left in the hole at the point of collapse while the temporary well is assembled. When the well is completely assembled, a final auger bucket of material is quickly removed and the well is immediately inserted into the borehole, pushing, as needed, to achieve maximum penetration into the saturated materials.

3.5 Temporary Monitoring Well Types

Five types of monitoring wells which have been shown to be acceptable are presented in the order of increasing difficulty to install and increasing cost:

3.5.1 No Filter Pack

This is the most common temporary well and is very effective in many situations. After the borehole is completed, the casing and screen are simply inserted. This is the least expensive and fastest well to install. This type of well is extremely sensitive to turbidity fluctuations because there is no filter pack. Care should be taken to not disturb the casing during purging and sampling.

3.5.2 Inner Filter Pack

This type differs from the "No Filter Pack" well in that a filter pack is placed inside the screen to a level approximately 6 inches above the well screen. This ensures that all water within the casing has passed through the filter pack. For this type well to function properly, the static water level must be at least 6-12 inches above the filter pack. The screen slots may plug in some clayey environments with this construction method and others that use sand only inside the well screen.

3.5.3 Traditional Filter Pack

For this type of well, the screen and casing are inserted into the borehole, and the sand is poured into the annular space surrounding the screen and casing. Occasionally, it may be difficult to effectively place a filter pack around shallow open boreholes, due to collapse. This method requires more sand than the "inner filter pack" well, increasing material costs. As the filter pack is placed, it mixes with the muddy water in the borehole, which may increase the amount of time needed to purge the well to an acceptable level of turbidity.

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3.5.4 Double Filter Pack

The borehole is advanced to the desired depth. As with the "inner filter pack" the well screen is filled with filter pack material and the well screen and casing inserted until the top of the filter pack is at least 6 inches below the water table. Filter pack material is poured into the annular space around the well screen. This type temporary well construction can be effective in aquifers where fine silts or clays predominate. This construction technique takes longer to implement and uses more filter pack material than others previously discussed.

3.5.5 Well-in-a-Well

The borehole is advanced to the desired depth. At this point, a 1-inch well screen and sufficient riser is inserted into a 2-inch well screen with sufficient riser, and centered. Filter pack material is then placed into the annular space surrounding the 1-inch well screen, to approximately 6 inches above the screen. The well is then inserted into the borehole.

This system requires twice as much well screen and riser, with attendant increases in assembly and installation time. The increased amount of well construction materials results in a corresponding increase in decontamination time and costs. The use of pre-packed well screens in this application will require rinse blanks of each batch of screens. Pre-pack Screen assemblies can not be decontaminated for reuse.

3.6 Decommissioning

Temporary well boreholes must be decommissioned after sampling and removal of the screen and riser. Backfilling the holes with cuttings may be acceptable practice for shallow holes in uniform materials with expected low contamination levels. Use of cuttings would not be an acceptable practice if waste materials were encountered or a confining layer was breached. Likewise, where the borehole is adjacent to, or downgradient of contaminated areas, the loose backfilled material could create a highly permeable conduit for contaminant migration. If the borehole will not be backfilled with the soil cuttings for this or other reasons, then SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202, should be referenced regarding disposal of the cuttings as IDW.

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4 Temporary Monitoring Well Installation Using the Geoprobe® Screen Point 15/16 Groundwater Sampler

4.1 Introduction

The Geoprobe® Screen Point 15/16 Groundwater Sampler is a discrete interval ground water sampling device that can be pushed to pre-selected sampling depths in saturated, unconsolidated materials. Once the target depth has been reached, the screen is opened and groundwater can be sampled as a temporary monitoring well, which yields a representative, uncompromised sample from that depth. Using knock-out plugs, this method also allows for grouting of the push hole during sample tool retrieval.

The Screen Point® 15 sampler consist of four parts (drive point, screen, sampler sheath and drive head), with an assembled length of 52 inches (1321 mm) and a maximum OD of 1.5 inches (38 mm). When opened, it has an exposed screen length of 41 inches (1041 mm). It is typically pushed using 1.25-inch probe rod. The Screen Point® 16 consists of the same parts and works in the same fashion, the only differences being larger diameter and its use with 1.5” rods.

4.1.1 Assembly of Screen Point® 15/16 Groundwater Sampler

1. Install O-ring on expendable point and firmly seat in the angled end of the sampler sheath.

2. Place a grout plug in the lower end of the screen section. Grout plug material should be chosen with consideration for site specific Data Quality Objectives (DQOs).

3. When using stainless steel screen, place another O-ring* in the groove on the upper end of the screen and slide it into the sampler sheath.

4. Place an O-ring* on the bottom of the drive head and thread into the top of the sampler sheath.

5. The Screen Point® 15/16 Groundwater Sampler is now assembled and ready to push for sample collection.

   * It should be noted that O-ring use in steps 3 and 4 are optional.

4.1.2 Installation of Screen Point® 15/16 Groundwater Sampler

1. Attach drive cap to top of sampler and slowly drive it into the ground. Raise the hammer assembly, remove the drive cap and place an O-ring* in the top groove of the drive head. Add a probe rod and continue to push the rod string.

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2. Continue to add probe rods until the desired sampling depth is reached.

3. When the desired sampling depth is reached, re-position the probe derrick and position either the casing puller assembly or the rod grip puller over the top of the top probe rod.

4. Thread a screen push adapter on an extension rod and attach sufficient additional extension rods to reach the top of the Screen Point® 15/16 sampler. Add an extension handle to the top of the string of extension rods and run this into the probe rod, resting the screen push adapter on top of the sampler.

5. To expose the screened portion of the sampler, exert downward pressure on the sampler, using the extension rod and push adapter, while pulling the probe rod upward. To expose the entire open portion of the screen, pull the probe rod upward approximately 41 inches.

6. At this point, the Screen Point® 15/16 Groundwater Sampler has been installed as a temporary well and may be sampled using appropriate ground water sampling methodology. If waters levels are less than approximately 25 feet, EIB personnel typically use a peristaltic pump, utilizing low-flow methods, to collect ground water samples from these installations. If water levels are greater than 25 feet, a manual bladder pump, a micro bailer, or other method may have to be utilized to collect the sample (SESD Operating Procedure for Groundwater Sampling, SESDPROC-301-R0) provides detailed descriptions of these techniques and methods).

4.1.3 Special Considerations for Screen Point® 15/16 Installations

Decommissioning (Abandonment)

In many applications, it may be appropriate to grout the abandoned probe hole where a Screen Point® 15/16 sampler was installed. This probe hole decommissioning can be accomplished through two methods which are determined by location and contamination risk. In certain non-critical areas, boreholes may be decommissioned by filling the saturated zone with bentonite pellets and grouting the vadose zone with neat cement poured from the surface or Bentonite pellets properly hydrated in place. Probe holes in areas where poor borehole sealing could present a risk of contaminant migration should be decommissioned by pressure grouting through the probe rod during sampler retrieval. To accomplish this, the grout plug is knocked out of the bottom of the screen using a grout plug push adapter and a grout nozzle is fed through the probe rod, extending just below the bottom of the screen. As the probe rod and sampler

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are pulled, grout is injected in the open hole below the screen at a rate that just fills the open hole created by the pull. Alternatively, the screen can generally be pulled and the hole re-probed with a tool string to be used for through-the-rod grouting.

Screen Material Selection

Screen selection is also a consideration in sampling with the Screen Point® 15/16 sampler. The screens are available in two materials, stainless steel and PVC. Because of stainless steel's durability, ability to be cleaned and re-used, and overall inertness and compatibility with most contaminants, it is the material typically used during EIB investigations.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Specific Conductance Measurement**

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-101-R2, *Field Specific Conductance Measurement*, replaces SESDPROC-101-R1 **Cover Page:** Author was changed from Marty Allen to Ron Phelps. **Revision History** Changed Field Quality Manager to Document Control Coordinator. **Section 1.3** Changed Field Quality Manager to Document Control Coordinator. **Section 2** Added requirements for unattended deployment of in-situ monitoring equipment. **Section 3.2** Added sentence to paragraph 2 to identify minimum requirements for calibration/verification. **Section 3.3** Moved operational check to Section 3.4.	June 13, 2008
SESDPROC-101-R1, *Field Specific Conductance Measurement*, replaces SESDPROC-101-R0 **General** Deleted all references to SOSA. Updated referenced procedures due to changes in title names and/or to reflect most recent version. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief.	November 1, 2007

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Section 1.3 Updated information to reflect that procedure is located on the H: drive of the LAN. **Section 1.4** Alphabetized and revised the referencing style for consistency. **Section 2** Added last paragraph regarding stopping measurements due to environmental conditions.	
SESDPROC-101-R0, Field Specific Conductance Measurement, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes procedures, methods and considerations to be used and observed when conducting field specific conductance measurements in aqueous phase environmental media, including groundwater, surface water and certain wastewaters.

1.2 Scope/Application

The procedures contained in this document are to be used by field investigator's when measuring the specific conductance of aqueous phase environmental media in the field. On the occasion that SESD field investigator's determine that any of the procedures described in this section cannot be used to obtain specific conductance measurements of the media being sampled, and that another method must be used to obtain said measurements, the variant instrument and/or measurement procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

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1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when conducting field specific conductance measurements. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

All field specific conductance measurements pertinent to the sampling event, including a unique, traceable identifier for the instrument, such as a property number or serial number, should be recorded in the field log book for the event. All records should be entered according to the procedures outlined in the SESD Operating Procedure Logbooks (SESDPROC-010).

Care should be taken not to contaminate standards and samples and verify the expiration date of all standards prior to use. All meters should be calibrated, operated and maintained according to the manufacturer's specifications.

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2 Quality Control

All specific conductance meters will be maintained and operated in accordance with the manufacturer's instructions and the SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108). Before a meter is taken to the field, it will be properly calibrated or verified, according to Section 3.2 of this procedure, to ensure it is operating properly. These calibration and verification checks shall be documented and maintained in a logbook.

The ambient temperature in the immediate vicinity of the meter should be measured and recorded in the field logbook to insure the instrument is operated within the manufacturer's specified range of operating temperatures. For instruments that are deployed for in-situ measurements, the temperature of the medium being monitored should be measured and recorded in the logbook prior to deployment. *In-situ monitoring equipment may be utilized in unattended deployments where autonomous logging may preclude temperature measurement prior to deployment. Because in situ instrumentation generally has a wide range of operating temperature, the field investigator may utilize professional judgment in determining if the operating environment is suitable for unattended deployment.*

If at any time during a field investigation, it appears that the environmental conditions could jeopardize the quality of the measurement results, the measurements will be stopped. This will be documented in the field logbook.

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3 Field Specific Conductance Measurement Procedures

3.1 General

Specific conductance is a measure of the ability of an aqueous solution to conduct an electric current and is customarily reported in micromhos per centimeter (µmhos/cm) at 25°C. It is important to note that if the specific conductance measurements are for NPDES reporting purposes, the meter and conductivity cell should be verified by comparing against a laboratory meter with a platinum-electrode type conductivity cell.

3.2 Instrument Calibration and Verification

The meter will be calibrated or verified in accordance with the manufacturer's instructions before it is taken into the field and prior to actual use.

Conductivity is affected by temperature; therefore, temperature should be read first so that appropriate adjustments can be made in accordance with the manufacture's instructions and the method. The following calibration/verification guidelines are minimum requirements:

1. Verify the meter's internal temperature sensor (thermistor) against a National Institute of Standards and Technology (NIST) traceable thermometer and note any differences between the thermistor and the NIST-traceable thermometer in the logbook. If the temperatures do not agree within ± 4°C, the unit must be repaired or replaced. Alternatively, if the meter can be used in a manual temperature compensation mode, the NIST-traceable thermometer may be used for temperature readings and the necessary corrections applied. Check and record the temperatures of the standards and the samples.

2. Rinse the probe with de-ionized water and blot dry before conducting the following calibration and verification checks.

3. Immerse the probe in the first standard solution and calibrate or verify the meter against that solution. After the initial standard, calibrate and/or verify the meter using additional standards, as appropriate. Rinse the probe with de-ionized water and blot dry or otherwise remove excess rinse water between the different standards. Record the standard values/temperatures used to calibrate or verify the meter.

   Note: Standards must reflect the anticipated specific conductance of the media being measured.

4. If the meter is not accurate to within ± 10 % of the standard solution(s) known values, the cell should be repaired or replaced, if possible. If this

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condition can be corrected by adjusting the cell constant of the probe, refer to the instruction manual and make the adjustment.

3.3 Sample Measurement Procedures

The following procedures must be followed when conducting field specific conductance measurements of grab samples:

1. Collect the sample, check and record its temperature.

2. Correct the instrument's temperature adjustment to the temperature of the sample (if required).

3. Immerse the probe in the sample keeping it away from the sides and bottom of the container. It is important that the center portion of the probe be wetted by the sample.

4. Allow meter to stabilize. Record the results in a log book.

5. Rinse probe with de-ionized water.

The following procedures should be followed when conducting in-situ field specific conductivity measurements:

1. Place the probe into the media to be measured and allow the specific conductivity and temperature readings to stabilize. Once the readings have stabilized, record the measurements in the logbook.

2. When deploying meters for extended periods of time, ensure the measurement location is representative of average media conditions.

3.4 Operational Check

A post-operation instrument verification check should be performed using the appropriate standard(s) at the end of the day or after all measurements have been taken for a particular period of operation. These measurements must be recorded in the field log book.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

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Revision History

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History	Effective Date
SESDPROC-102-R3, *Field Temperature Measurement*, replaces SESDPROC-102-R2 **Cover Page:** Author was changed from Ron Phelps to Hunter Johnson. The Enforcement and Investigations Branch Chief was changed from Antonio Quinones to Archie Lee. The FQM was changed from Laura Ackerman to Liza Montalvo. **Section 1.2:** Added the following statement: Mention of trade names or commercial products does not constitute endorsement or recommendation for use. **Section 1.3:** Omitted the reference to the H: drive of the LAN. **Section 1.5:** In Section 1.5.1, added "The field investigators will" to the first sentence. Deleted Section 1.5.2. **Section 2:** In the first paragraph, kept the first sentence but replaced the rest of the paragraph with the following language for clarification purposes: "Temperature measurement devices such as pH, conductivity and dissolved oxygen (DO) meter thermistors will be verified against a National Institute of Standards and Technology (NIST)-traceable thermometer before each use as described in Section 3.2. Data Sonde thermistors will be verified on a monthly basis to ensure accuracy. These verification checks are documented in the instrument's tracking logbook." Deleted the second paragraph. **Section 3.1:** In the first paragraph, replaced the first sentence with: "Field temperature measurements may be made with a field thermometer, equipment thermistor, or NIST-traceable thermometer." In the second sentence, replaced "thermometer" with "temperature measurement device." **Section 3.2:** Created new sections 3.2.1 and 3.2.2 as follows: Converted the "Note" to new section 3.2.1. Replaced the first sentence with "Temperature measurement devices such as field thermometers and equipment thermistors will be verified against a NIST-traceable thermometer prior to use and should agree within ± 4.0°C." Converted the first paragraph to section 3.2.2. Revised the original language to clarify the verification requirements of the NIST-traceable thermometers that are used to verify other temperature measuring devices, such as field thermometers and equipment thermistors.	February 4, 2011

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Section 3.3: Replaced “thermometer” with “temperature measurement device.” **Section 3.4:** Added “if not in-situ” to number 4.	
SESDPROC-102-R2, *Field Temperature Measurement*, Replaces SESDPROC-102-R1 **Cover Page:** Author was changed from Marty Allen to Ron Phelps. **Revision History** Changed Field Quality Manager to Document Control Coordinator. **Section 1.3** Changed Field Quality Manager to Document Control Coordinator. **Section 2** Deleted last sentence of paragraph 1. Deleted Fisher brand stem type in paragraph 2. **Section 3.1** Deleted “Normally” on the first sentence. Deleted the last sentence. **Section 3.2** Changed “Calibration” to “Verification.” Added recalibration requirements.	June 13, 2008
SESDPROC-102-R1, *Field Temperature Measurement*, Replaces SESDPROC-102-R0 **General** Updated referenced procedures due to changes in title names and/or to reflect most recent version. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove’s title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that procedure is located on the H: drive of the LAN. **Section 1.4** Alphabetized and revised the referencing style for consistency. **Section 2** Added last paragraph regarding stopping measurements due to environmental conditions.	November 1, 2007
SESDPROC-102-R0, Field Temperature Measurement, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when measuring the temperature of aqueous phase environmental media, including groundwater, surface water and certain wastewaters.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when measuring the temperature of aqueous phase environmental media in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section cannot be used to obtain temperature measurements of the media being sampled, and that another method or measurement instrument must be used to obtain said measurements, the variant instrument and measurement procedure will be documented in the field log book and subsequent investigation report, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

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1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when conducting temperature measurements in the field. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. The field investigators will address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

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2 Quality Control

All thermometers should be maintained and operated in accordance with the manufacturer's instructions and the SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108). Temperature measurement devices such as pH, conductivity and dissolved oxygen (DO) meter thermistors will be verified against a National Institute of Standards and Technology (NIST)-traceable thermometer before each use as described in Section 3.2. Data Sonde thermistors will be verified on a monthly basis to ensure accuracy. These verification checks are documented in the instrument’s tracking logbook.

If at any time during a field investigation, it appears that the environmental conditions could jeopardize the quality of the measurement results, the measurements will be stopped. This will be documented in the field logbook.

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3 Field Temperature Measurement Procedures

3.1 General

Field temperature measurements may be made with a field thermometer, equipment thermistor, or NIST-traceable thermometer. At a minimum, the temperature measurement device should be capable of measuring in 0.1°C increments.

3.2 Instrument Verification

3.2.1 Field thermometers and thermistors

Temperature measurement devices such as field thermometers and equipment thermistors will be verified against a NIST-traceable thermometer prior to use and should agree within ± 4.0°C. Corrections may be applied for measurements up to ± 4.0°C depending on investigation objectives, but the instrument must be repaired or replaced beyond that range.

3.2.2 NIST-traceable thermometer

Verification of the NIST-traceable thermometers that are used to verify temperature measuring devices is accomplished by comparing temperature readings from the NIST-traceable thermometer to a thermometer that has an independent certification of accuracy traceable to the National Institute of Standards and Testing. Current certified thermometers are maintained by the SESD Analytical Support Branch and are called reference thermometers.

Each NIST-traceable thermometer is verified by comparing at least annually against a reference thermometer. If corrections need to be applied, they will be noted in the NIST-traceable thermometer. Depending on investigation objectives, project leaders may decide to apply the correction factor as necessary.

3.3 Inspections

All temperature measurement devices should be inspected for leaks, cracks, and/or function prior to each use.

3.4 Sample measurement procedures for thermometers/thermistors

(Make measurements in-situ when possible)

1. Clean the probe end with de-ionized water and immerse into sample.

2. If not measuring in-situ, swirl the instrument in the sample for mixing and equilibration.

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3. Allow the instrument to equilibrate with the sample for at least one minute.

4. Suspend the instrument away from the sides and bottom, if not in-situ, to observe the temperature reading.

5. Record the reading in the log book. For most applications, report temperature readings to the nearest 0.5°C or to the nearest 0.1°C depending on need.

Note: Always clean the thermometer with de-ionized water or a detergent solution, if appropriate, prior to storage and/or use.

3.5 Units

Degrees Celsius (°C) or Degrees Fahrenheit (°F)

Conversion Formulas:

°F = (9/5 °C) + 32 or °C = 5/9 (°F - 32)

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Turbidity Measurement**

Effective Date: June 13, 2008	**Number:** SESDPROC-103-R2

Authors

Name: Ron Phelps
Title: Environmental Scientist
Signature: Ron Phelps Date: 6-2-08

Approvals

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Title: Chief, Enforcement and Investigations Branch
Signature: Date: 6/3/08

Name: Bill Cosgrove
Title: Chief, Ecological Assessment Branch
Signature: Date: 6/2/08

Name: Laura Ackerman
Title: Field Quality Manager, Science and Ecosystem Support Division
Signature: Laura Ackerman Date: 06/02/08

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Revision History

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History	Effective Date
SESDPROC-103-R2, *Field Turbidity Measurement*, Replaces SESDPROC-103-R1 **Cover Page:** Author was changed from Marty Allen to Ron Phelps. **Revision History** Changed Field Quality Manager to Document Control Coordinator. **Section 1.3** Changed Field Quality Manager to Document Control Coordinator.	June 13, 2008
SESDPROC-103-R1, *Field Turbidity Measurement*, Replaces SESDPROC-103-R0 **General** Deleted all references to SOSA. Updated referenced procedures due to changes in title names and/or to reflect most recent version. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that procedure is located on the H: drive of the LAN. **Section 1.4** Alphabetized and revised the referencing style for consistency. **Section 2** Added last paragraph regarding stopping measurements due to environmental conditions.	November 1, 2007

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Section 3.5 Re-phrased operational check 2 for clarity.	
SESDPROC-103-R0, Field Turbidity Measurement, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when conducting field turbidity measurements in aqueous phase environmental media, including groundwater, surface water and certain wastewaters.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when measuring turbidity of various, aqueous phase environmental media in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section cannot be used to obtain turbidity measurements of the media being sampled, and that another method or turbidity measurement instrument must be used to obtain said measurements, the variant instrument and measurement procedure will be documented in the field log book, along with a description of the circumstances requiring it's use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

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1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when conducting field turbidity measurements. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. When using this procedure, minimize exposure to potential health hazards through the use of protective clothing, eye wear and gloves. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

All field turbidity measurements pertinent to the sampling event should be recorded in the field log book for the event. All records should be entered according to the procedures outlined in the SESD Operating Procedure for Logbooks (SESDPROC-010).

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2 Quality Control

All turbidity meters and probes shall be maintained and operated in accordance with the manufacturer's instructions and the SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108). Before a meter or probe is taken to the field, it shall be properly calibrated and verified, according to Sections 3.2 and 3.3 of this procedure, to ensure it is operating properly. These calibration and verification checks shall be documented and maintained in a logbook.

The ambient temperature in the immediate vicinity of the meter should be measured and recorded in the field logbook to insure the instrument is operated within the manufacturer's specified range of operating temperatures. For instruments that are deployed for in-situ measurements, the temperature of the medium being monitored should be measured and recorded in the logbook prior to deployment. *In-situ monitoring equipment may be utilized in unattended deployments where autonomous logging may preclude temperature measurement prior to deployment. Because in situ instrumentation generally has a wide range of operating temperature, the field investigator may utilize professional judgment in determining if the operating environment is suitable for unattended deployment.*

If at any time during a field investigation, it appears that the environmental conditions could jeopardize the quality of the measurement results, the measurements will be stopped. This will be documented in the field logbook.

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3 Field Turbidity Measurement Procedures

3.1 General

Turbidity is caused by suspended and colloidal matter such as clay, silt, organic and inorganic matter and microscopic organisms. Many methods are available for the measurement of turbidity including turbidimeters and optical probes. Turbidity is measured by determining the amount of scatter when a light is passed through a sample.

3.2 Meter Calibration and Verification

1. The turbidimeter is calibrated or verified in accordance with the manufacturer's instructions prior to use in the field. If the instrument readings do not agree within ± 10 % of the calibration standards, the unit must be recalibrated, repaired or replaced. These verifications should be documented in the field investigator's logbook.

2. Turn the meter "ON".

3. Rinse the sample cell three times with organic-free or de-ionized water.

4. Fill the cell to the fill line with organic-free or de-ionized water and then cap the cell.

5. Use a non-abrasive, lint-free paper or cloth (preferably lens paper) to wipe off excess water and streaks.

6. Open the cover and insert the cell (arrow to the front) into the unit and close the cover.

7. Press "READ" and wait for the value to be displayed.

8. Using the verification standards, repeat steps 4, 5, and 6. Record all measurements.

3.3 Probe Calibration and Verification

1. The probe is calibrated in accordance with the manufacturer's instructions prior to use in the field. If the instrument readings do not agree within ± 10 % of the calibration standards, the unit must be recalibrated, repaired or replaced. These calibrations should be documented in the field investigator's logbook.

2. Turn the meter "ON" and allow it to stabilize.

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3. Immerse the probe in the first standard solution and calibrate the probe against the solution.

4. Rinse the probe with de-ionized water, remove excess rinse water and calibrate the probe using additional standards as appropriate.

5. Record the standard values used to calibrate the meter.

3.4 Sample Measurement Procedures

These procedures should be followed when conducting turbidity measurements of grab samples:

1. Collect a representative sample and pour off enough to fill the cell to the fill line (about 15 mL) and replace the cap on the cell.

2. Wipe off excess water and any streaks with a soft, lint-free cloth (lens paper).

3. Press I/O and the instrument will turn on. Place the meter on a flat, sturdy surface. Do not hold the instrument while making measurements.

4. Insert the sample cell in the instrument so the diamond or orientation mark aligns with the raised orientation mark in the front of the cell compartment. Close the lid.

5. Select manual or automatic range selection by pressing the range key.

6. Select signal averaging mode by pressing the Signal Average key. Use signal average mode if the sample causes a noisy signal (display changes constantly).

7. Press Read. The display will show ---- NTU. Then the turbidity is displayed in NTU. Record the result after the lamp symbol turns off.

8. Rinse the cell with de-ionized water.

These procedures should be followed when conducting in-situ turbidity measurements:

1. Place the probe into the media to be measured and allow the turbidity reading to stabilize. Once the reading has stabilized, record the measurement in the logbook.

2. When deploying meters for extended periods of time, insure the measurement location is representative of average media conditions.

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3.5 Operational check

1. If possible, periodically check the turbidity meter during the day by using the appropriate turbidity standards.

2. A post-operation instrument verification check should be performed using the appropriate standards at the end of the day or after all measurements have been taken for a particular period of operation. These measurements must be recorded in the field log book.

3.6 Units

Turbidity measurements are reported in nephelometric turbidity units (NTUs). It is important to note that if the turbidity measurements are for NPDES reporting purposes, all values above 40 NTU must be diluted with turbidity free water and calculated by multiplying by a dilution factor.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Groundwater Level and Well Depth Measurement**

Effective Date: November 1, 2007	**Number:** SESDPROC-105-R1

Authors

Name: Donald Hunter
Title: Environmental Scientist, Regional Expert
Signature: Donald Hunter Date: 11/02/07

Approvals

Name: Antonio Quinones
Title: Chief, Enforcement and Investigations Branch
Signature: Date: 11/02/07

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Signature: Laura Ackerman Date: 11/02/07

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Revision History

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History	Effective Date
SESDPROC-105-R1, *Groundwater Level and Well Depth Measurement*, replaces SESDPROC-105-R0 **General** Updated referenced procedures due to changes in title names and/or to reflect most recent version. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. **Section 1.3** Updated information to reflect that procedure is located on the H: drive of the LAN. **Section 1.4** Alphabetized and revised the referencing style for consistency.	November 1, 2007
SESDPROC-105-R0, Groundwater Level and Well Depth Measurement, Original Issue	February 05, 2007

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Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when determining water levels and depths of wells.

1.2 Scope/Application

The procedures contained in this document are to be used by field investigators to measure water levels and depths of wells. On the occasion that SESD field investigators determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used for water level or depth determination, the variant procedure(s) will be documented in the field log book and the subsequent investigation report, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

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1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when measuring water levels in wells and determining their depths. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when measuring water levels and depths of wells:

- Special care must be taken to minimize the risk of cross-contamination between wells when conducting water level and depth measurements. This is accomplished primarily by decontaminating the sounders or other measuring devices between wells, according to SESD Operating Procedure for Field Equipment Cleaning and Decontamination, (SESDPROC-205) and maintaining the sounders in clean environment while in transit between wells.
- Water levels and well depths measured according to these procedures should be recorded in a bound logbook dedicated to the project as per SESD Operating Procedure for Logbooks (SESDPROC-010). Serial numbers, property numbers or other unique identification for the water level indicator or sounder must also be recorded.

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2 Quality Control Issues

There are several specific quality control issues pertinent to conducting water level and depth measurements at wells. These are:

- Devices used to measure groundwater levels should be calibrated annually against the Invar® steel surveyor's chain. These devices should be calibrated to 0.01 foot per 10 feet of length. Before each use, these devices should be prepared according to the manufacturer's instructions (if appropriate) and checked for obvious damage. All calibration and maintenance data should be documented electronically and recorded in a log book maintained at the Field Equipment Center (FEC) as per the SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108).
- These devices should be decontaminated according to the procedures specified in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) prior to use at the next well.

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3 Water Level and Depth Measurement Procedures

3.1 General

The measurement of the groundwater level in a well is frequently conducted in conjunction with ground water sampling to determine the "free" water surface. This potentiometric surface measurement can be used to establish ground water direction and gradients. Groundwater level and well depth measurements are needed to determine the volume of water in the well casing prior to purging the well for sampling purposes.

All groundwater level and well depth measurements should be made relative to an established reference point on the well casing and should be documented in the field records. This reference point is usually identified by the well installer using a permanent marker, for PVC wells, or by notching the top of casing with a chisel, for stainless steel wells. By convention, this marking is usually placed on the north side of the top of casing. If no mark is apparent, the person performing the measurements should take both water level and depth measurements from the north side of the top of casing and note this procedure in the field log book.

To be useful for establishing groundwater gradient, the reference point should be tied in with the NGVD (National Geodetic Vertical Datum) or a local datum. For an isolated group of wells, an arbitrary datum common to all wells in that group may be used, if necessary, and is acceptable.

3.2 Specific Groundwater Level Measurement Techniques

Measuring the depth to the free ground water surface can be accomplished by the following methods. Method accuracies are noted for each of the specific methods described below.

- Electronic Water Level Indicators – These types of instruments consist of a spool of dual conductor wire, a probe attached to the end and an indicator. When the probe comes in contact with the water, the circuit is closed and a meter light and/or audible buzzer attached to the spool will signal contact. Penlight or 9-volt batteries are normally used as a power source. Measurements should be made and recorded to the nearest 0.01 foot.

- Other Methods – There are other types of water level indicators and recorders available on the market, such as weighted steel tape, chalked tape, sliding float method, air line pressure method and automatic recording methods. These methods are primarily used for closed systems or permanent monitoring wells. Acoustic water level indicators are also available which measure water levels based on the measured return of an emitted acoustical impulse. Accuracies for these methods vary and should be evaluated before selection. Any method not capable of providing measurements to within 0.1 foot should not be used.

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3.3 Total Well Depth Measurement Techniques

The well sounder, weighted tape or electronic water level indicators can be used to determine the total well depth. This is accomplished by lowering the tape or cable until the weighted end is felt resting on the bottom of the well. Because of tape buoyancy and weight effects encountered in deep wells with long water columns, it may be difficult to determine when the tape end is touching the bottom of the well. Sediment in the bottom of the well can also make it difficult to determine total depth. Care must be taken in these situations to ensure accurate measurements. All total depth measurements must be made and recorded to the nearest 0.1 foot. As a cautionary note, when measuring well depths with the electronic water level indicators, the person performing the measurement must measure and add the length of the probe beneath the circuit closing electrodes to the depth measured to obtain the true depth. This is necessary because the tape distance markings are referenced to the electrodes, rather than the very end of the probe.

3.4 Equipment Available

The following equipment is available for ground water level and total depth measurements:

- Weighted steel measuring tapes
- Electronic water level indicators

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Measurement of Dissolved Oxygen**

Effective Date: February 12, 2010	**Number:** SESDPROC-106-R2

Author

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Signature: Date: 2/12/10

Approvals

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Name: Bill Cosgrove
Title: Chief, Ecological Assessment Branch
Signature: Date: 2/12/10

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Signature: Date: 2/11/10

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This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-106-R2, *Field Measurement of Dissolved Oxygen*, replaces SESDPROC-106-R1 **General** Corrected any typographical, grammatical, and/or editorial errors. **Title Page** Changed author from Laura Ackerman to Hunter Johnson. Changed Chief, Enforcement and Investigations Branch from Antonio Quinones to Archie Lee. Changed Field Quality Manager from Laura Ackerman to Liza Montalvo. **History** Changed Field Quality Manager to Document Control Coordinator. **Section 1.1** Added treated wastewater. **Section 1.3** Omitted reference to the H: drive. Changed the Field Quality Manager to the Document Control Coordinator. **Section 2** Omitted sentence in paragraph 1 regarding labeling meters to indicate time of next calibration. Omitted "shall" in paragraph one and added "will". Reworded paragraph 3. Added sentence in paragraph 4 to identify minimum requirements for calibration. Added sentences in paragraph 5 regarding in situ instrumentation range of operating temperature. **Section 3.1** Added the last sentence on NPDES compliance. **Section 3.2** Added sentence in paragraph 3 regarding	February 12, 2010

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verification of temperature probe or thermistor by using NIST traceable thermometer. Added sentence in last paragraph regarding recording of data. **Section 3.4** Clarified first bulleted guideline. **Section 3.5** Added Section 3.5.	
SESDPROC-106-R1, *Field Measurement of Dissolved Oxygen*, replaces SESDPROC-106-R0 **General** Deleted all references to SOSA. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that procedure is located on the H: drive of the LAN. **Section 1.4** Updated referenced procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 2** Updated referenced procedures due to changes in title names. Added last paragraph regarding stopping measurements due to environmental conditions.	November 1, 2007
SESDPROC-106-R0, *Field Measurement of Dissolved Oxygen*, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes methods and considerations to be used and observed when conducting field measurements of dissolved oxygen in surface water, treated wastewater, and in gas media for specific applications (e.g., diffusion measurement).

1.2 Scope/Application

On the occasion that SESD field investigators determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another method must be used to obtain a measurement of dissolved oxygen, the alternate procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD Local Area Network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

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1.5 General Precautions

1.5.1 Safety

Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. When using this procedure, minimize exposure to potential health hazards through the use of protective clothing, eye wear and gloves. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

Appropriate precautions should be observed when working in and around bodies of water and on boats. Be aware of fast flowing waters, waterway obstructions such as dams, and other vessels on the water.

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2 Quality Control

All dissolved oxygen meters will be maintained and operated in accordance with the manufacturer's instructions and the SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108). Before a meter is taken to the field, it will be calibrated and verified, according to Section 3.2 of this procedure, to ensure it is operating properly. These calibration and verification checks will be documented and maintained in a logbook.

For in-situ measurements, an instrument warm-up period appropriate for that instrument should be provided. Consult manufacturer's documentation for appropriate warm-up time.

A 24 hour burn-in period is recommended for Clark Cell probes after changing the membrane to allow the membrane to stabilize.

Winkler titrations should be performed in pairs. If the resulting DO measurements are not within 0.2 mg/l, the samples should be discarded and a new pair run. When the water-saturated air calibration method is utilized the DO measurement should be within 4% of the air's known calculated saturated value.

The ambient temperature in the immediate vicinity of the meter should be measured and recorded in the field logbook to insure the instrument is operated within the manufacturer's specified range of operating temperatures. For instruments that are deployed for in-situ measurements, the temperature of the medium being monitored should be measured and recorded in the logbook prior to deployment. *In-situ monitoring equipment may be utilized in unattended deployments where autonomous logging may preclude temperature measurement prior to deployment. Because in situ instrumentation generally has a wide range of operating temperature, the field investigator may utilize professional judgment in determining if the operating environment is suitable for unattended deployment.*

Following instrument use, an end check should be performed using one of the techniques described in Section 3.2 to quantify potential instrument drift during use.

If at any time during a field investigation, it appears that the environmental conditions could jeopardize the quality of the measurement results, the measurements will be stopped. This will be documented in the field logbook.

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3 Field Measurement of Dissolved Oxygen

3.1 General

Dissolved oxygen can be defined as the volume of oxygen contained in a volume of water. The solubility of oxygen in water is dependant on the water temperature, salinity, and pressure. As the temperature of the water decreases, the solubility of oxygen increases. As salinity increases, the solubility of oxygen decreases. And finally, as the pressure decreases (altitude increases), the solubility of oxygen decreases. Several methods for measurement of dissolved oxygen in water are available, including iodometric methods (Winkler Titration), Clark cell probes and luminescent probes. When measuring dissolved oxygen for compliance with the National Pollutant Discharge Elimination System (NPDES) Program, only approved methods will be used. Approved methods can be found in the Code of Federal Regulations (CFR) 40 CFR Part 136.

3.1.1 Iodometric Method (Winkler Titration)

The iodometric method (Winkler Titration) for measuring dissolved oxygen in water is the most precise and reliable titrimetric procedure for dissolved oxygen analysis. It is based on the addition of divalent manganese solution, followed by strong alkali, to the sample in a glass stoppered bottle. The dissolved oxygen rapidly oxidizes an equivalent amount of the dispersed divalent manganous hydroxide precipitate to hydroxides of higher valency states. In the presence of iodide ions in an acidic solution, the oxidized manganous reverts to the divalent state and releases an amount of iodine equivalent to the dissolved oxygen content. The iodine is then titrated with a standard solution of thiosulfate. Oxidizing and reducing materials may be present in the sample and can cause interferences with the iodometric method. The most common interference is from nitrite. The azide modification effectively removes interferences caused by nitrite. Consult Standard Methods for the Examination of Water and Wastewater, Part 4500-O for additional information regarding measurement of dissolved oxygen in water using the Azide Modified Winkler Titration method.

Using this method, careful collection of the sample is paramount to prevent aeration of the sample during collection. The sample should be collected into a 300 ml glass bottle with a ground glass air-tight cap. The sample may be transferred from the collection site to the bottle using a submersible pump or a submerged horizontal sampler (e.g., Van Dorn) fitted with tubing at the outlet. The tubing is inserted to the bottom of the sample bottle and the bottle is allowed to overfill to purge any entrained air. After allowing the bottle to overfill, slowly remove the tubing and gently cap the bottle. The sample is then ready for iodometric analysis.

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3.1.2 Clark Cell Probes

Clark cell probes utilize an oxygen permeable membrane that covers an electrolytic cell which consists of a cathode and an anode. The anode acts as a reference electrode. After passing through the permeable membrane, the oxygen is reduced by an applied potential voltage that is referenced to the anode. The reduction current at the cathode is directly proportional to the partial pressure of oxygen in liquid, expressed as %-air saturation. The concentration of oxygen, in mg/l, is calculated based on the %-air saturation reading and the solubility of oxygen in water at the sample temperature.

In general, sample collection using a DO probe requires only lowering the probe into the sample media and recording or logging the results. The probe should be lowered gently to prevent damage to the membrane and gently turned when initially lowered to remove any attached air bubbles. If the instrument requires the use of a stirrer, the stirrer should be turned on before recording any readings. Prior to use, the instrument should be calibrated and any manufacturer specified warm-up period should be observed.

3.1.3 Luminescent Probes

Luminescent dissolved oxygen probes employ a light emitting diode (LED) to provide incident light, which excites the oxygen-sensitive luminescent-dye molecule substrate of the sensor. After dissipation of the excitation energy, longer-wavelength light is emitted (luminescence). The magnitude of steady-state luminescence (intensity) is measured by the sensor and is inversely proportional to the dissolved oxygen concentration.

Sample collection with this type of probe should follow the sample procedures described in the second paragraph of Section 3.1.2 for Clark Cell probes.

3.2 Calibration

The iodometric method of dissolved oxygen measurement is an analytical technique used to quantify the amount of oxygen in water and certain wastewaters and therefore, does not require calibration. The iodometric method can be used to assist with calibration of instruments designed to measure dissolved oxygen *in-situ*.

Many brands of instruments are commercially available for *in-situ* measurement of dissolved oxygen using Clark cell probes and luminescent probes. The manufacturer's instruction manual should be consulted for specific procedures regarding their calibration, maintenance and use. Calibration of any measurement instrument must be conducted and/or verified prior to each use or on a daily basis, whichever is most appropriate.

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In general, calibrations should be conducted at temperatures and pressures as close as possible to those of the sample media for the most accurate measurements. Due to the sensitivity of dissolved oxygen measurements to changes in temperature, the temperature probe or thermistor should be verified using a NIST traceable thermometer prior to each calibration. Most dissolved oxygen meters utilize a one-point calibration which is performed using either water saturated air, air-saturated water or the iodometric method. When using the water-saturated air method, the probes should be placed in a 100% relative humidity environment and the temperature and dissolved oxygen readings should be allowed to equilibrate. After equilibration, the meter should be set to read the appropriate dissolved oxygen concentration based on the temperature and barometric pressure.

When using air-saturated water for calibration, an aeration device such as an aquarium pump with a diffusion stone should be placed in a vessel containing tap water. The water in the vessel should be aerated for a minimum of one hour at a constant temperature. Saturation should be verified by placing the dissolved oxygen probe in the vessel and monitoring the temperature and dissolved oxygen readings for stabilization. Avoid placing the probe in the direct stream of air bubbles. Bubbles can accumulate on the probe surface and cause erroneous readings. Once the water is saturated, the temperature of the water and the barometric pressure can be used to determine the dissolved oxygen value. The meter can then be set to read that value.

The iodometric method for calibration requires filling a vessel with de-ionized water or tap water which has been dechlorinated by sitting exposed to the air for 24 hours then performing an Azide Modified Winkler Titration to determine the dissolved oxygen concentration of the water. The temperature of the water should remain constant throughout the calibration process. Once the dissolved oxygen concentration has been determined, the probe should be placed in the water and allowed to equilibrate. Following equilibration, the meter should be set to read the concentration of dissolved oxygen determined using the Winkler titration. During calibration, the dissolved oxygen concentration, temperature, and barometric pressure should be recorded.

3.3 Maintenance

Maintenance procedures vary depending on the technology utilized by each instrument and the manufacturer. The manufacturer's instruction manual should be consulted fore instrument specific procedures. Following are some general guidelines for maintaining dissolved oxygen meters:

- Inspect probes for damage prior to use.
- For Clark cell probes, membranes and electrolyte solution should be changed prior to each study, when feasible.
- Battery voltages should be checked. For meters that will be deployed unattended, new or fully charged batteries should be used for each study.

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- All calibration and maintenance procedures performed should be thoroughly documented.

3.4 Conducting Field Measurement of Dissolved Oxygen

Following are guidelines for conducting field measurements of dissolved oxygen:

- Except as described in specific operating procedures, dissolved oxygen measurements should if possible be conducted *in-situ*.
- When measuring DO at distinct points in the water column, the probe should be allowed to equilibrate at each location prior to recording the measurement.
- In water bodies with a great deal of flow, a weight may be attached to the probe guard or support cable to insure the probe is maintained at the proper depth.
- Insure that the measurement location is representative of conditions within the water body or reach. Avoid measurements directly below turbulent sections or still water unless these conditions represent most of the water body or reach.
- If DO measurements are conducted in saline water, the DO meter should either be capable of correcting for salinity or a separate instrument should be used to measure salinity so that the final DO measurements can be corrected.

3.5 Operational Check

A post-operation instrument verification check will be performed using one of the techniques described in Section 3.2 to quantify potential instrument drift during use. A verification check will be performed at the end of all measurements for a day or at the end of a deployment. The verification DO concentration will be measured and recorded in the field logbook prior to any instrument adjustment.

It may be appropriate to check the calibration of a DO meter periodically during the course of a day's measurements when conducting individual measurements rather than deploying an instrument. When this is done, it should be noted in the field logbook. The calibration of meters checked throughout the day maybe adjusted if drift is occurring.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Equipment Inventory and Management**

Effective Date: April 6, 2009	**Number:** SESDPROC-108-R3

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator (DCC).

History	Effective Date
SESDPROC-108-R3, *Equipment Inventory and Management*, replaces SESDPROC-108-R2. **General Information** Previous versions of the document will be maintained by the Document Control Coordinator (DCC). Changed from Field Quality Manager (FQM) to DCC. **Title Page** Changed EIB Branch Chief from Antonio Quinones to Archie Lee. **Section 1.3** Changed requirement so that the DCC is responsible for ensuring the most recent version of the procedure is placed on the SESD H: drive and for maintaining records of review conducted prior to its issuance. **Section 1.6** Added reference to Analytical Support Branch Standard Operating Procedure for the Certification of Laboratory Thermometers, SOP ASB 100G. **Section 2.2.2** Removed requirement that the BFEM will maintain copy of all paperwork associated with the purchase of equipment. **Section 2.3.1** Removed requirement that the BFEM send the current copy of the equipment inventory to the FQM. The BFEM will maintain the current list of equipment subject to the procedure. Modified #9 to state that the inventory list will include a reference to the manufacturer's instruction manual title. **Section 2.3.2** Removed requirement that FQM will ensure that duplicate identification numbers are not assigned to equipment. BFEMs will be responsible for ID numbers. **Section 2.4.2** Removed requirement that the BFEM must notify the FEC personnel via email that the repaired equipment has been returned. **Section 2.6, #2** Acceptance record will be a copy of the signed invoice.	April 6, 2009

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SESDPROC-108-R2, *Equipment Inventory and Management*, replaces SESDPROC-108-R1. **General** Changed title on cover page for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. **Section 1.6** Corrected form number for Load-In Form from SESDFORM-012 to SESDFORM-011. **Section 2.4.2** Corrected form number for Load-In Form from SESDFORM-012 to SESDFORM-011. Added last paragraph regarding adversely impacted data. **Section 2.5** Added second sentence regarding pos-calibration verification checks for equipment. Added forth and fifth sentences regarding calibration acceptance criteria. Added second paragraph pertaining to outside calibration services. **Section 2.3.1** Added item 9.	October 19, 2007
SESDPROC-108-R1, *Equipment Inventory and Management*, replaces SESDPROC-108-R0. **Section 1.1** Modified purpose to include equipment that may come into direct contact with the sample media and has the potential to cross contaminate samples between sampling stations **Section 1.2** Modified scope to include microscopes, volumetric equipment and equipment that may come into direct contact with the sample media (i.e. submersible pumps) and has the potential to cross contaminate samples between sampling stations **Section 1.3** Modified requirements for maintaining official copy of procedure. **Section 1.5** Combined section 1.5.1 and 1.5.2. Added "maintenance" to list of manufacturer's directions to follow. Added that a copy of the instruction manual will be provided with sampling equipment to be taken in the field. **Section 2.1** Added equipment that comes in direct contact with sample media to list of equipment covered under the procedure. Added reference to decontamination procedures. **Section 2.2** Renamed Section 2.2 to include equipment receipt. Added Section 2.2.2 (Receiving Equipment). Section 2.2.1 - Modified and expanded the purchase of equipment procedure. Removed reference to SESDPROC-015.	October 1, 2007

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Section 2.3 Incorporated inventory procedures from SESDPROC-104 to this section. Added Section 2.3.1 -Equipment Labeling and Marking. **Section 2.4** Added critical spare parts will be sent out with equipment. Section 2.4.2 - Changed email notification to written notification. Included reference to SESDFORM-011. Added procedures for equipment that require software upgrades. **Section 2.5** Included visual inspection of equipment. Added reference to equipment that is not directly used for field measurement and added that calibration and measurement requirements are found in individual measurement procedures. Added maintenance procedure for microscopes and volumetric equipment. Changed title of Section 2.5.2 to include certification and verification records. Changed storage location of NIST Certificates. Defined NIST as National Institute of Standards and Technology. Added language to verify the quality of equipment. Added procedure for the verification of thermometers. Section 2.5.3 – Added that records of calibration will be maintained in equipment log books and procedure for returning equipment unsuitable for use. **Section 2.6** Changed requirement from the original Purchase Order to a copy of the order will be maintained by the branch field equipment managers. **Section 2.8** Removed Section from operating procedure **Section 2.9** Removed Section 2.9 from operating procedure. Information on the glove and bottle return policy was added to Section 2.6 of SESDPROC-011-R1.	
SESDPROC-108-R0, Equipment and Supply Management, Original Issue.	May 4, 2007

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Contents

1 General Information

1.1 Purpose

This document describes the procedures necessary to demonstrate the operational status and inventory of equipment used for field measurement activities and equipment that comes into direct contact with the sample media and has the potential to cross contaminate samples between sampling stations.

1.2 Scope/Application

This procedure covers the approaches and documentation used for the purchase, maintenance, calibration, verification, and inventory of equipment used for direct field measurement activities. This procedure includes the maintenance and use of microscopes, volumetric equipment and equipment that may come into direct contact with the sample media (i.e. submersible pumps) and has the potential to cross contaminate samples between sampling stations.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the SESD H: drive and for maintaining records of review conducted prior to its issuance.

1.4 Definitions

1.4.1 Calibration

The set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system and corresponding known values. The results of a calibration permit the estimation of errors associated with the measurement equipment.

1.4.2 Calibration Verification

Provides a means of determining that deviations between measured values and known values are within the limits of error defined during calibration. The results provide an indication that the instrument/system is working properly.

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1.4.3 Preventative Maintenance

A program of routine actions such as cleaning, lubrication, adjusting, or testing to keep equipment ready for use. The most important effect of a preventative maintenance program is to ensure measurement system reliability.

1.4.4 Branch Field Equipment Manager

Staff, designated by management, who are responsible for ensuring that the procedures for Equipment Inventory and Management are followed. At least one Branch Field Equipment Manager (BFEM) will be designated for the Enforcement and Investigations Branch (EIB) and the Ecological Assessment Branch (EAB).

1.4.5 Qualified Individual

Individual who has received on the job training and has experience working with specific measurement instruments.

1.4.6 Equipment Log

Notebook, log book, or electronic file that contains a copy of the purchase order, if available, as well as, maintenance, calibration, and verification records, performance checks, correction factors, and sign-out/sign-in records. Equipment logs will be established for all equipment used for field measurement activities or equipment that comes into direct contact with the sample media and has the potential to cross contaminate samples between sampling stations. The development of equipment logs is the responsibility of the Branch Field Equipment Managers.

1.5 Precautions

To ensure the safe and reliable operation of equipment, the manufacturers' directions for transport, cleaning, decontamination, storage, maintenance, and operation of equipment will be followed. When possible, a copy of the instruction manual will be provided with sampling equipment to be taken in the field. In addition, field activities will be conducted in accordance to the SESD Safety, Health, and Environmental Management Program (SHEMP).

Handling of contaminated equipment is addressed under the following operating procedures: Field Equipment Cleaning and Decontamination at the Field Equipment Center (SESDPROC-206) and Field Equipment Cleaning and Decontamination (SESDPROC-205).

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1.6 References

American National Standard ANSI/ASQC M1-1996, *Calibration Systems*

American National Standard ANSI/NCLS Z2540-1-1994, *Calibration Laboratories, and Measuring and Test Equipment - General Requirements*

SESD Safety, Health and Environmental Management Program (SHEMP) Manual, most recent version.

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, most recent version.

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, most recent version.

SESD Operating Procedure for Competency and Proficiency Testing, SESDPROC-006, most recent version.

SESD Operating Procedure for Purchasing of Services and Supplies, SESDPROC-015, most recent version.

SESD Operating Procedure for Control of Nonconforming Work, SESDPROC-019, most recent version.

FEC Loan-In Form, SESDFORM-011, most recent version.

Analytical Support Branch Standard Operating Procedure for the Certification of Laboratory Thermometers, SOP ASB 100G.

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2 Methodology

2.1 General

Equipment (hardware and related software) used for field measurement activities and equipment that comes into direct contact with the sample media and has the potential to cross contaminate samples between sampling stations will meet quality requirements identified for each piece of equipment. Important factors in establishing quality requirements include the parameters to be measured and the sensitivity and specificity of the detection system used. Quality requirements must include ensuring that equipment is ready for use. Specifically:

1. SESD will have adequate equipment to conduct measurement activities.

2. Equipment used for field measurement activities will be capable of achieving the accuracy and precision required by the measurement objectives.

3. When SESD is required to use environmental data collection equipment outside its permanent control, it will ensure that all relevant SESD criteria in this procedure are met.

4. Field measurement equipment used by SESD will be secured at all times, as feasible, based on field conditions.

5. Operating instructions and/or manuals from the manufacturer will be available for each piece of equipment, when possible.

6. Field investigators will only operate equipment for procedures which they are authorized per SESDPROC-006 to perform.

7. Equipment used for field measurements will be handled, transported, shipped, stored, and operated in a manner that prevents damage, gross contamination, and deterioration. Equipment will be handled and maintained in accordance to the manufacturer's operating instructions. Decontamination of equipment will be in accordance to procedures described in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) and Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206).

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2.2 Equipment Purchase and Receipt

2.2.1 Purchasing Equipment

Equipment covered in this procedure is purchased using procurement requests (PR) or purchase card orders and can be initiated by the BFEM or designee. The initiator of a purchase is responsible for preparing a PR or purchase card order that specifies the correct name of the item, the relevant quality criteria of the item, the item number, a quote or price, possible sources and any other associated information that helps identify the correct item to be purchased. The sources identified must be capable of providing the equipment according to the defined specifications. A copy of the purchase order or purchase card order will be maintained in the equipment log. Once the order has been prepared, the information is forwarded to the appropriate BFEM for origination of the purchase and management will authorize and sign the order and forward it to the purchasing official. The purchasing official will ensure the order is processed according to the information on the PR or purchase card order.

2.2.2 Receiving Equipment

Anyone can accept delivery of equipment orders. For equipment purchases received at the SESD laboratory, the BFEM or initiator of the purchase will inspect the items to ensure they comply with the PR or purchase card order. If the items are acceptable, the BFEM or initiator will sign and date the invoice that accompanied the order and any other required documentation and forward it to the purchasing official. The purchasing official will maintain a file of all SESD purchases.

For purchases received at the Field Equipment Center, contract personnel will inspect the items to ensure they comply with the PR or purchase card order. If the items are acceptable, the contract personnel will sign and date the invoice that accompanied the order and any other required documentation and forward it to the appropriate BFEM. The original paperwork (signed invoice) will be forwarded to the purchasing official.

If any equipment is found to be unsuitable for use, the BFEMs will document the problems and any action taken to correct that problem. The documentation will include a description of the item, the deficiency and the vendor. The BFEM will also compile all occurrences of unsuitable consumables, supplies or services and determine what further corrective action may be necessary and notify the Field Quality Manager if deemed necessary.

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2.3 Equipment Inventory

2.3.1 Inventory

The BFEMs are responsible for maintaining a current equipment inventory list for their specific areas. The BFEMs will maintain a central, comprehensive list of all field measurement and sampling equipment subject to this procedure. Field measurement equipment, including sampling equipment that comes into contact with the sample media and has the potential to cross contaminate samples between stations (i.e., submersible pumps and vacuum chambers), will be included in this inventory. The equipment inventory list for each instrument or piece of equipment will include:

1. A description of the property and software, if applicable (e.g., pH meter, dissolved oxygen meter, etc.).
2. Manufacturer or vendor name
3. Model number
4. Serial number or other manufacturer identification number
5. A unique identifier, known as the SESD ID Number. These identifiers will be assigned by the BFEM.
6. Storage location (e.g., Field Equipment Center, SESD Laboratory)
7. Date received and/or date placed in service, where available.
8. Status of the equipment (e.g., surplus, damaged, etc.)
9. A reference to the manufacturer's instruction manual title.

2.3.2 Equipment Labeling and Marking

Prior to being placed into the equipment inventory, all equipment covered under this procedure will be inventoried and labeled with a unique SESD identification number. The identification number will be assigned only to the identified equipment and will not be reused if the meter is excised or disposed. Equipment that is no longer used or cannot be repaired will be removed from the inventory.

Equipment received after the effective date of this procedure will be assigned a number that includes the date the equipment was received followed by a sequential number starting at 01 (e.g., 031407-01, 031407-02, etc.). BFEMS will ensure that duplicate SESD ID Numbers are not assigned to equipment.

Equipment received before the effective date of this operating procedure will be assigned a number that will incorporate all or part of the serial number or other manufacturer number as the unique SESD ID number.

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2.4 Equipment Maintenance

Maintenance will consist of preventative care and corrective repair. Both approaches should be used to keep equipment in working order. Each item of field measurement equipment will be checked by a qualified individual prior to use. Critical spare parts, which cannot be easily obtained while in the field, will be sent out with the equipment during field investigations.

Equipment maintenance will include software upgrades for certain instruments. SESD management will assign staff to serve as a point of contact for equipment, such as GPS or Sondes that may require periodic software upgrades in order to collect field measurements. The point of contact will ensure that software upgrades are conducted on all equipment. The point of contacts will maintain a list of the equipment which will include the serial number, SESD ID Number, software version, software upgrade dates, and the storage location of the equipment. The point of contact will provide the information to the appropriate BFEM to be included in the equipment inventory.

2.4.1 Documentation

The BFEMs are responsible for the development of equipment logs. Maintenance, calibration, and verification requirements for equipment will be documented in the log book.

2.4.2 Repair and Re-certification for Use

Equipment known or suspected to be defective will be taken out of service and clearly labeled, preferably with a red tag, until it has been repaired and shown by calibration, verification, or testing to function properly. When equipment is tagged in the field as defective, the SESD project leader will notify the appropriate BFEM in writing, either by email or by using a load-in form (SESDFORM-011), that equipment requires repair.

For equipment maintained at the FEC which is routinely handled and maintained by contract personnel, the BFEM will be responsible for having the equipment repaired. Once repaired, the BFEM will notify the FEC contract personnel that the equipment has been returned. The contract personnel will ensure that the equipment is functioning properly prior to it being used for field investigations. The BFEMs are responsible for placing all documentation associated with the equipment repair in the appropriate maintenance section of the equipment log. This documentation includes written notifications regarding the equipment repair and any information provided from the manufacturer which describes the defect and the repair.

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For equipment stored at the SESD laboratory, or stored at the FEC and not routinely handled and maintained by contract personnel, the BFEM or a designated qualified individual will be responsible for having the equipment repaired. Once repaired, the BFEM or qualified individual will ensure the equipment is functioning properly prior to it being used for field investigations. The BFEM or qualified individual is responsible for placing all documentation associated with the repair of equipment stored at the SESD laboratory in the appropriate maintenance section of the equipment log. This documentation includes the written notifications regarding the equipment repair and any information provided which describes the defect and the repair.

If there is the potential that data collected with defective equipment were adversely impacted, the BFEM will notify the appropriate Branch Quality Assurance Officer (QAO). The QAO will notify affected management and The Field Quality Manager and the issue will be handled according to the SESD Operating Procedure for Control of Nonconforming Work (SESDPROC-019).

2.4.3 Required Maintenance

The BFEMs are responsible for ensuring that equipment maintenance is performed in-house or by an outside service.

2.4.4 Record Keeping

Records of all maintenance, service, repairs, and histories of any damage, malfunction, or modification of field measurement equipment will be maintained in the equipment logs. The record will describe hardware and software changes and/or updates and show the dates when these occurred.

2.5 Equipment Calibration

Prior to being used in the field, measurement equipment will be visually inspected and a calibration, calibration verification, or performance check will be conducted to ensure it is in working condition. A post-operation instrument verification check will be performed using the appropriate standard(s) at the end of the day or after all measurements have been taken for a particular period of operation. When practicable, equipment requiring calibration will be labeled to indicate the status of calibration and the date when re-calibration is due. Calibration acceptance criteria based on data quality objectives will be established on a case by case basis for each field study. Project Leaders will be responsible for ensuring the acceptance criteria are met. Calibration and measurement requirements are found in individual measurement procedures.

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When equipment or reference standards are calibrated by an outside calibration service, SESD will ensure the vendor is ISO 17025 accredited or has some other equivalent means for demonstrating competence, measurement capability and traceability.

All reasonable measures will be taken to safeguard equipment from adjustments which would invalidate the measurements following calibration of the equipment. Field investigators will handle, transport, and store equipment in accordance to manufacturer recommendations. Periodic calibration or performance checks will be conducted during field investigations to ensure that equipment calibration has not been adversely impacted between measurement locations.

For equipment that is not directly used for field measurement, visual examination, safety checks, or, if appropriate, performance checks, will be conducted by the FEC contract personnel or the project leader to ensure the working condition of the equipment. Microscopes, including attachments, will be cleaned and serviced as needed prior to use.

Volumetric equipment will be maintained by visual examination and cleaning at the Field Equipment Center. Performance checks will be conducted by the FEC contract personnel or the project leader prior to initial use and at intervals depending on the frequency of use.

2.5.1 Documentation

Records for equipment that is sent off-site for calibration recertification will be maintained in the equipment log books. All calibrations or calibration verifications performed at the SESD laboratory or Field Equipment Center will be recorded in the appropriate equipment log book.

All calibrations or calibration verifications performed in the field will be recorded in the project specific logbook(s) by the individual conducting the calibration or verification and stored in the associated project file. Calibration of equipment conducted by SESD field investigators and other qualified personnel will be conducted in accordance with the manufacturer's recommendations

When calibrations require correction factors, the correction factors will be documented in instrument operating procedures, equipment logs, and written methods (field logbooks).

2.5.2 Traceability, Certification, and Verification Records

The program for the calibration or calibration verification of equipment must ensure that, where the concept is applicable, all significant measurements are traceable through certificates of calibration held by SESD, and/or to National Standards of Measurement. National Institute of Standards and Technology

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(NIST) traceable standards will be used, if available. For equipment maintained at the FEC and sent off-site for calibration, certificates or other records of calibration will be maintained in a central file at the FEC. Additionally, NIST traceable documentation for buffers, standards, calibration gases, or reference materials will be maintained in a central file at the FEC.

For equipment maintained at the SESD laboratory and sent off-site for calibration certificates or other records of calibration will be maintained in the lab where the equipment is stored. Additionally, NIST traceable documentation for buffers, standards, calibration gases, or reference materials will be maintained in a central file at the SESD laboratory with the equipment.

SESD will maintain records of actions taken to verify the quality of equipment whose properties could affect the quality of sampling, measurement, and related activities. Examples would be thermometer, calibration standard or buffer verification. Thermometers used during field investigations will be verified by the SESD Analytical Support Branch (ASB) utilizing their Standard Operating Procedure for the Certification of Laboratory Thermometers, SOP ASB 100G. The SESD ASB is accredited by the National Environmental Laboratory Accreditation Conference.

Critical reference materials such as reagents and consumable materials that affect the quality of tests and/or calibrations will be verified according to the procedures described in the SESD Operating Procedure for Purchasing Services and Supplies, SESDPROC-015.

2.5.3 Equipment Performance Checks

New equipment will be calibrated or verified by qualified personnel to verify that it is adequate to perform its intended function, and calibrated before release for use in the field. Records of calibration or verification will be maintained in the equipment log books. If any equipment proves to be unsuitable for use, the BFEMs will document the issue, notify the purchasing official, and return the deficient equipment to the vendor.

If equipment leaves the direct control of SESD for a period of time, the BFEMs will ensure that the function and, where necessary, the calibration status of the equipment is checked and shown to be satisfactory before the equipment is returned to service.

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2.6 Records

The BFEMs are responsible for maintaining a current equipment inventory list for their specific programs. The FQM will maintain a central, comprehensive list of all field measurement and sampling equipment subject to this procedure.

The BFEMs are responsible for creating equipment logs for all equipment in their specific program used for field measurement activities. Additionally, they are responsible for auditing and maintaining equipment maintenance, calibration and verification records in the equipment logs. These records must be made available to SESD personnel prior to their use for field measurement.

These records will include:

1. A copy of the Purchase Order, if available, or other record showing item received and date placed into service
2. Acceptance inspection record of the equipment (copy of signed invoice)
3. Maintenance, calibration, and verification logs (including software if applicable)
4. Identification of individuals accessing maintenance, calibration, and verification logs
5. Calibration certificates for manufacturers calibrations (if applicable)
6. Fundamental calibration or any other performance checks information
7. Calibration verification record (showing standards/reference materials used)
8. Calibration correction factors, if applicable
9. Records of handling, transportation, and storage of equipment
10. Complaint log (if applicable)
11. A record of the most recent version of firmware or software for the equipment.

2.7 Equipment Sign-out/Sign-in

All measurement equipment will be signed-out prior to use in the field and signed-in following use in the field. This will be done using an equipment sign-out/sign-in form. Each form is specific to the type of measuring equipment being checked out and includes calibration or verification data, as well as, project name and project leader information.

FEC contract personnel will primarily be responsible for equipment sign-out and sign-in at the FEC. However, in their absence, it is the project leader's responsibility to sign out the measurement equipment. For measurement equipment that is not routinely handled or maintained by contract personnel or equipment stored at the SESD laboratory, the project leader or field investigator using the equipment is responsible for checking the equipment out and in.

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Each equipment log will contain an equipment sign-out/sign-in form. Equipment defects or damage that is identified while in the field should be noted on the FEC Load-In Form (SESD FORM-011) when the equipment is signed in.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Global Positioning System**

Effective Date: April 20, 2011	**Number:** SESDPROC-110-R3

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Revision History

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History	Effective Date
SESDPROC-110-R3, *Global Positioning System*, replaces SESDPROC-110-R2 **Cover Page:** The EIB Branch Chief was changed from Antonio Quinones to Archie Lee. The FQM was changed from Laura Ackerman to Liza Montalvo. **Revision History:** Changed Field Quality Manager to Document Control Coordinator. **Section 1.2:** Added the following statement: Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use. **Section 1.3:** Omitted the reference to the H: drive of the LAN. Changed Field Quality Manager to Document Control Coordinator.	April 20, 2011
SESDPROC-110-R2, *Global Positioning System*, replaces SESDPROC-110-R01 **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.4** Alphabetized and added a reference.	November 1, 2007
SESDPROC-110-R1, *Global Positioning System*, replaces SESDPROC-110-R0 This revision reflects the following changes: **General** Extensive rewrite with additional information added to most sections. Brian Striggow added as coauthor. **Section 2.1** Rewritten description of GPS system. Descriptions of "GPS Accuracy Factors" and "Differential GPS" isolated as separate subsections.	October 1, 2007

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Section 2.2 This Section, titled “Requirements for Locational Information” inserted. Supplies guidance on accuracy requirements for various study types and potential means used to obtain requisite accuracy. Subsection on datums and data formats included. **Section 2.3** “Quality Control Procedures”, previously numbered as Section 2.2. Most information in this section moved to Section 2.1 discussion of Accuracy Factors and Section 2.4 discussion of specific receivers. Explicit statement added that no specific GPS quality control procedures are required for most SESD studies. **Section 2.4** Information added to sections on Trimble and Garmin receivers. **Section 2.5** Issue of electronic data-logging addressed. Storage of electronic data records addressed.	
SESDPROC-110-R0, Global Positioning System, Original Issue	March 22, 2007

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Contents

1 General Information

1.1 Purpose

This document describes the Global Positioning System (GPS) and procedures, methods and considerations to be used and observed when using GPS to record location data in the field. Guidance is provided on accuracy requirements for various uses of location data and potential means to obtain the requisite accuracy. This document contains direction developed solely to provide internal guidance to SESD employees.

1.2 Scope/Application

The procedures contained in this document are to be used by SESD field investigators when using the Global Positioning System to obtain the geographical coordinates of sampling locations and/or measurements during field investigations. In SESD investigations, GPS is the preferred means of collecting horizontal location information. In most cases the accuracy of GPS is unsuitable for collection of elevation data.

On the occasion that SESD field personnel determine that any of the procedures described in this section cannot be used to obtain the required coordinate information and alternate procedures are employed, the alternate procedure will be documented in the field log book, along with a description of the circumstances requiring its use. GPS users must be currently qualified as proficient in the operation of the specific GPS equipment to be used. The manufacturer's operation manuals should be used for detailed information on the use of specific GPS equipment. Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

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1.4 References

Rand Corporation, The Global Positioning System, Assessing National Policies, Appendix B, GPS History, Chronology, and Budgets, 1995.

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version.

Trimble® Navigation Limited, Mapping Systems General Reference, Revision B, 1996.

USEPA, Global Position Systems – Technical Implementation Guidance, Office of Environmental Information (EPA/250/R-03/001), 2003.

USEPA, GIS Technical Memorandum 3. Global Positioning Systems – Technology and It's Application in Environmental Programs, Research and Development (PM-225). EPA/600/R-92/036, 1992.

USEPA, Locational Data Policy, Office of Information Resources Management, IRM Policy Manual 2100 Chapter 13, 1991.

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2 Methodology

2.1 General

2.1.1 GPS Description

The Navigation Satellite Time and Ranging (NAVSTAR) Global Positioning System (GPS) is a worldwide radio-navigation system created by the U. S. Department of Defense (DOD) to provide navigation, location, and timing information for military operations. System testing using a limited number of satellites began in 1978 with the system being declared fully operational in 1995. The system was declared available for civilian uses in the 1980s and has seen burgeoning civilian application for navigation and mapping.

The GPS system consists of three basic elements: the space segment, control segment, and user segment. The space segment consists of the constellation of up to 24 active NAVSTAR satellites in six orbital tracks. The satellites are not in geo-synchronous orbit and are in constant motion relative to a ground user. The control segment consists of several ground stations that serve as uplinks to the satellites and that make adjustments to satellite orbits and clocks when necessary. The user segment consists of the GPS receiver which will typically consist of an antenna, multi-channel receiver, and processing unit.

For the purposes of this document, the user segment GPS receivers may be loosely grouped into Recreational and Navigational receivers (henceforth referred to as General Use receivers), Mapping Grade receivers, and Survey Grade receivers.

- Most General Use grade receivers are available on the retail market to consumers for a variety of applications including boating, hiking, and automotive navigation. They display an instantaneous reading of position and are generally not optimized for data collection. Waypoints containing instantaneous position fixes can often be stored and downloaded. The accuracy of these receivers is adequate for many environmental applications.

- Mapping Grade receivers are used for applications such as resource management and Geographical Information System (GIS) feature collection. The receivers are capable of averaging multiple position fixes for greater accuracy and then data-logging the results with sufficient information to post-correct the positions as described below. The potential accuracy that can be achieved may be better than one meter.

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- Survey Grade receivers can provide accuracy at the centimeter level by using long occupation times and special techniques for receiver use and data processing. Survey Grade receivers are not used by SESD in field investigations.

GPS receivers derive positions by simultaneously measuring the distance (range) to several satellites in precisely known orbits, and using triangulation of the ranges to calculate a unique position for the receiver. The range to each satellite is determined by precisely measuring the transit time of radio signals broadcast from the satellites.

2.1.2 GPS Accuracy Factors

The accuracy of the basic GPS system is approximately 15m. GPS accuracy can be affected by a number of factors including the Selective Availability feature, atmospheric delays, satellite clock and orbit errors, multipath signals, signal strength, and satellite geometry relative to the user.

In the early GPS implementation, the DOD used a feature known as Selective Availability (SA) to degrade the quality and subsequent accuracy of the GPS signals to non-DOD users. With Selective Availability enabled, accuracy of position fixes could be as poor as 100m without the use of differential correction techniques described below. Currently there is no SA limitation in accuracy in place with a stated Executive Branch intention to not return to the use of the SA signal degradation.

As satellites move in their orbits and some signals are blocked by obstructions, the geometry of the available satellite signals relative to the user will constantly change. When the satellites with available signals are clustered closely together in the sky, small errors in range will result in large errors in reported position. Conversely, when the satellites are distributed more broadly across the sky, the resultant position errors will be at their minimum. The general measure of this phenomenon is Dilution of Precision (DOP), which may be represented as Position Dilution of Precision (PDOP), or more specifically for geographical coordinate collection, Horizontal Dilution of Precision (HDOP). Mapping and Survey Grade receivers generally can calculate and display DOP and allow the user to limit logging to times when the higher potential accuracy conditions of low DOP prevail. General Use receivers may display DOP and use DOP with other factors to estimate a general accuracy figure. DOP may range from approximately 2 to 50, with high quality work usually requiring a HDOP of less than 4-6.

Signal strength and multipath signals relate to the strength and quality of the signal reaching the receiver antenna. Signal attenuation by the atmosphere, buildings, and tree cover limit the accuracy of the ranges obtained. The measure of signal strength is Signal to Noise Ratio (SNR), generally measured in decibels(db). Most receivers of any grade will display the SNR of the satellite signals in a bar graph or table. Mapping Grade Receivers generally allow the user to specify a minimum signal strength for the use of a satellite signal (commonly 2-15db). Poor signal strength can be resolved by waiting for satellite locations to change or moving the receiver location. Multipath signals result

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from portions of the satellite signal bouncing off terrain, structures, or atmospheric disturbances, resulting in a degraded total signal. Higher quality Mapping Grade receivers may be capable of rejecting the stray multipath signals, such as Trimble® receivers using Everest™ technology.

2.1.3 Differential GPS

Selective Availability, clock errors, and orbital errors affect all GPS users and atmospheric delays affect all users over a relatively wide region. A second GPS receiver in the same general area as the user will experience the same errors from these sources as the user's receiver. Consequently, correction factors from a remote station at a known location can be applied to the user's receiver in a process known as Differential GPS (DGPS). DGPS can be applied in real-time using additional radio signals, or after the collection event by a method called post-correction.

Real-time DGPS uses established networks of base stations at precisely surveyed locations. The US Coast Guard operates a system of 80 base stations which became fully operational in 1999. The range corrections are broadcast on marine radiobeacon frequencies, with redundant coverage of most of the US coastline and the Mississippi River. There is near complete single beacon coverage of most of the internal US, but there are known gaps in coverage in both EPA Region 4 and the US as a whole. The system is sometimes referred to using the more general term DGPS or in nomenclature referring to the beacon-based nature of the system. Beacon-based DGPS is implemented primarily in Navigational and Mapping Grade receivers.

Real-time DGPS can also be implemented with a Space Based Augmentation System (SBAS). The most common SBAS currently used in the United States is the Wide Area Augmentation System (WAAS), developed by the Federal Aviation Administration to meet the additional demands on GPS for aircraft navigation. The WAAS network of base stations collects information on satellite clock errors, orbital errors, and atmospheric conditions. The error information is transferred to satellites in geo-synchronous orbits and subsequently broadcast to suitably equipped GPS receivers on frequencies compatible with the GPS range signals. While beacon-based DGPS passes range corrections to the receivers, WAAS communicates a model for the errors which is capable of providing more accurate corrections. Current Mapping Grade receivers will likely use WAAS with or without the option of beacon-based DGPS. All but the least expensive General Use receivers are generally equipped with WAAS differential correction capability.

Post-Corrected DGPS is generally accomplished by downloading the receiver survey files to a desktop or laptop computer and then retrieving correction files for the same time period (generally via the internet) from an established base station in the area of the survey. Post-processed accuracy improves with proximity of the base station to the surveyed locations and base station data should be used from a station within 300km of the site surveyed. The survey positions are processed by application software and a new

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set of positions is generated using the correction data. The capability for post-processed differential correction is generally limited to Mapping Grade and Survey Grade receivers.

Various factors limit GPS accuracy in the vertical plane to approximately half of that obtainable in the horizontal plane, i.e., if a location fix is accurate to 3 m in the horizontal plane, it may only be accurate to 6 m in the vertical plane. Since relatively high accuracy is usually required for the uses of elevation data, GPS is rarely used to obtain and report elevations.

2.2 Requirements for Locational Information

2.2.1 Data Uses

Locational information can serve many purposes in an environmental investigation, a few of which are listed below:

1. Providing an unambiguous means to identify facilities or sampling plats.
2. Providing locational information to key analytical data in a GIS based data archiving system to the original sampling locations.
3. Differentiating watersheds.
4. Providing information to calculate extents and volumes of contamination.
5. Providing a means to relocate the media represented by samples for removal or treatment.
6. Providing information to prepare presentation graphics of sampling locations.

Depending on the specific uses for the data and the type of work being performed, there will be different needs for the accuracy of the locational data. Studies where a sample represents a large area of relatively homogeneous material would not require the same accuracy as the location of a permanent monitoring well. Below are broad guidelines for the accuracy that might be required for different applications.

Desired Accuracy	Application
100 m	Open ocean work where sample is presumed to be representative of a large area
20 m	Open water work (lakes or estuaries) where sample is presumed to be representative of a large area
10 m	Stream and river work where samples are presumed to be broadly representative of a reach
5-3 m	Stream work where samples are representative of a specific narrowly defined section

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10 m	Air Monitoring Stations
10 - 3 m	Microscale air monitoring
3 - 1 m	Permanent monitoring wells
1 m	Locations of 'Hot Spots' destined for removal of limited areal extent
3 - 1 m	Locations of Temporary groundwater wells in plumes requiring narrow delineation
3 m	Locations of Temporary groundwater wells in broad plumes
3 m	Locations of environmental samples with sample spacing >20 m
5 m	Locations of environmental samples with sample spacing >60 m
200 - 20 m	Coordinates describing a facility where mobile waste units are sampled
30 - 3 m	Locations of industrial process areas or NPDES permitted facilities where the sampling locations are described in field notes relative to the process or site features

Specific demands of a study may drive increased or decreased requirements for accuracy. The preferred means of locational data collection for most studies will be GPS, although alternate means are permissible if they meet accuracy requirements. The following table indicates the accuracy that may be expected from various means of establishing coordinates.

Accuracy	**Description**
200 - 50 m	Map Derived, coarse work
40 - 20 m	Map Derived, fine work or using GIS with digital imagery
15 m	General Use Grade GPS, w/o WAAS
5 m	General Use Grade GPS, w/ WAAS or beacon corrections
10 m	Mapping Grade GPS, no corrections, averaged readings,
3 m	Mapping Grade GPS w/ differential correction, averaged readings
1 m	Mapping Grade GPS w/ differential correction, controlled DOP and SNR, averaged readings
10 cm	Surveying Grade GPS or optical surveying (dependent on baseline length)

Accuracy is a term used to describe the degree of conformity of a measurement. In GPS, accuracy is usually specified as an estimate of the radius from the measured coordinates that is likely to include the actual coordinates. The estimate is based on several standard deviations probability of including the actual point in the measurement. As such, it is recognized that some measurements will fall outside of the specified accuracy. For the purposes of SESD GPS work, the nominal accuracy figures derived from manufacturer's literature for specific operating conditions, displayed by the receiver at the time of feature collection, or output from processing software will be taken at face value.

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2.2.2 Datums and Data formats

In general, a datum is a reference from which other measurements are taken. In the development of surveying systems by civil entities, different datums were used as base references that will result in differing coordinates for the same location. A GPS receiver will generally display coordinates in a number of different user-selected datums. **Unless there are specific requirements on a project, all SESD work should be conducted using the WGS84 datum. A**lternatively, the nearly equivalent NAD83 datum may be used if WGS84 is unavailable as a receiver option. If an alternate coordinate system is used where coordinates are obtained and recorded in field logbooks, the use of the alternate coordinate system should also be noted in the logbook.

The SESD Data Archival and Retrieval System (DART) requires that coordinates for sample locations be entered in the WGS84 datum and dd.dddddd format. Unless specific project requirements dictate otherwise, all coordinates explicitly stated in reports will be in WGS84 format and in all cases the datum used will be specified.

There is no SESD policy on significant digits for GPS information, and accuracy should not be implied from the presence of significant digits in reported coordinates. However, good scientific practice should be followed in the presentation of locational information in order that useful information not be truncated or a higher degree of accuracy implied. The following table shows the incremental distance in latitude represented by the least significant digit for various coordinate formats:

dd.dddddd°	Approximately 4" or 10 cm
dd.ddddd°	Approximately 44" or 1.1 m
dd.dddd°	Approximately 36' or 11 m
dd°mm’ss”	Approximately 100' or 30 m
dd°mm’ss.x”	Approximately 10' or 3 m
dd°mm’ss.xx”	Approximately 1' or 30 cm
dd°mm.xxxx’	Approximately 7" or 18 cm
dd°mm.xxx’	Approximately 6' or 1.8 m
dd°mm.xx’	Approximately 60' or 18 m

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2.3 Quality Control Procedures

By nature of its origin in the DOD and recent application to aircraft navigation, the GPS is designed for high reliability. GPS failures resulting in an incorrect reading beyond the bounds of known errors are so rare that the possibility can be ignored for most SESD studies. If a study requires the verification of receiver function, this can be accomplished by verifying that a receiver displays the correct position while occupying a known benchmark.

2.4 Special Considerations

The application will dictate the type of receiver used. There are several specific considerations for the use of the various receiver types.

2.4.1 Special considerations for the use of Trimble® Mapping Grade Receivers

The suggested settings for Trimble® receivers are:

1. Position mode: Overdetermined 3D (or manual 3D if only 4 satellites are visible)
2. Elevation mask: 15 degrees
3. PDOP: 6
4. Signal to noise ratio (SNR) mask: 6
5. Dynamics code: Land
6. Logging interval: 1 second for points, 5 seconds for lines and areas
7. Audible click: Yes
8. Log DOP data: Yes
9. Coordinate System: Geographic Datum WGS84

When using Trimble® Geoexplorer receivers, the option of using the accuracy ‘slider bar’ display may be used to consolidate many of the above parameters. The slider bar position must be positioned at midscale or towards the ‘Precision’ end of the scale to achieve 1m accuracy work. When conducting work requiring less accuracy, the slider should be initially positioned midscale and may be adjusted toward the Production’ end of the scale if the higher level of accuracy can not be maintained.

The receivers may be configured to force real-time position correction. The use of real-time correction reduces the risk of being unable to obtain appropriate post-correction files, but may limit productivity when differential signals cannot be

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received or are intermittent. The use of forced real-time vs. post-correction is an operator decision. If the positions are not to be downloaded and the accuracy of differential correction is required, it will be necessary to force real-time correction.

Trimble® receivers at SESD contain a data dictionary that can facilitate the management of GIS data. If the COC_GIS dictionary is selected at the time of file creation, SESD standard media codes can be assigned to features at the time of logging that will accompany the data through the download process. The use of the COC_GIS data dictionary can simplify the management of the data when processed in a GIS system or when entered into the DART system.

The logging interval of most Trimble® GPS receivers defaults to a 5 second interval. This may be changed to a 1 second interval to expedite feature collection. A point feature should have a minimum of 36 positions logged to obtain the additional accuracy afforded by averaging positions. After a minimum of 36 positions are logged and the feature is closed, the averaged position can be obtained by selecting the feature on the 'Map' screen. The averaged position should always be the one entered into field notebooks.

Some Trimble® receivers may only display data in dd°mm'ss.sss" format. If the coordinates are downloaded and processed through Pathfinder Office software, they can be output in the dd.dddddd (or any other) format. If the coordinates were only recorded in field logbooks, they can be converted to decimal degrees as follows:

Converting to decimal degrees (dd.dddddd) from degrees°minutes'seconds" (dd°mm'ss.sss"):

dd.dddddd = dd + (mm/60) + (ss.sss/3600)

Example: Convert 33°28'45.241" to decimal degrees

33 + (28/60) + (45.241/3600) = 33.479236

The reverse conversion is accomplished as follows:

Converting to degrees°minutes'seconds" from decimal degrees

Starting with dd.dddddd

Multiply .dddddd by 60 to obtain mm.mmmm

Multiply .mmmm by 60 to obtain ss.sss

Then dd°mm'ss.sss" = dd & mm & ss.sss

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Example: Convert 33.479236 to dd°mm’ss.sss” format

Multiply .479236 by 60 to obtain 28.7540 (mm.mmmm)

Multiply .7540 by 60 to obtain 45.241 (ss.sss)

Dd°mm’ss.sss” = 33° & 28’ & 45.241” = 33°28’45.241”

2.4.2 Special considerations for the use of Garmin® General Use Grade Receivers

The standard format for navigational purposes is decimal minutes (dd°mm.mmm’). This format is utilized due to the fact that nautical navigation charts are set up in this format. However, location information must be converted to a decimal degree (dd.ddddd°) format in order for GIS software to properly interpret the information. The conversion is accomplished by dividing the minutes portion of the coordinates by 60.

<u>Converting to decimal degrees from decimal minutes:</u>

dd.ddddd° = dd + (mm.mmm/60)

Example: Convert 81°49.386 degrees to decimal degrees

81 + (49.386/60) = 81.8231 degrees

<u>The reverse conversion is accomplished as follows:</u>

dd°mm.mmm’ = dd & (.ddddd*60)

Example: Convert 81.8231 degrees to decimal minutes (dd°mm.mmm’)

Multiply .8231 by 60 to obtain 49.386 (mm.mmm)

81° & 49.386’ = 81°49.386’

GPS users need to familiarize themselves with the differences between the two formats, as they appear similar. Spreadsheets can automate the conversion process.

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2.5 Records

The GPS coordinates and the SESD equipment identification number of the GPS receiver should be recorded in field logbooks at the time of GPS coordinate collection. The data logging capability of receivers may be used in lieu of the requirement to record the coordinates in logbooks when the following conditions can be met:

1. The location can easily be found later if it needs to be resurveyed prior to demobilization. A permanent monitoring well can easily be resurveyed, while most open-water work would not afford this opportunity.

2. The data is downloaded and ascertained to meet the accuracy requirements for the project prior to demobilization from the site.

3. The data is stored in at least two separate locations for transport, such as a laptop hard drive and a flash drive or compact disc.

In all cases where positions are electronically recorded, the provisions of the Electronic Records section of the SESD Operating Procedure for Control of Records (SESDPROC-002) should be followed.

Where locational data is collected and processed electronically, but not reported explicitly in the final report, a copy of the coordinates in text format should be output and entered into the project file in paper or electronic form. The output should include:

1. Latitude, generally in dd.dddddd format.

2. Longitude, generally in dd.dddddd format.

3. Date of collection.

4. DOP information where it supports the accuracy requirements.

5. Correction status of each point where it supports the accuracy requirements.

6. The datum used for the export.

Trimble® Pathfinder Office will create files with this information by exporting to a text file. The information will be contained in the .pos and .inf files.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **In Situ Water Quality Monitoring**

Effective Date: December 7, 2009	**Number:** SESDPROC-111-R2

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SESDPROC-111-R1, *In Situ Water Quality Monitoring*, replaces SESDPROC-111-R0 **General** Updated referenced procedures due to changes in title names and/or to reflect the most recent version. **Title Page** Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that procedure is located on the H: drive of the LAN. **Section 1.5** Alphabetized and revised the referencing style.	November 1, 2007
SESDPROC-111-R0, In Situ Water Quality Monitoring, Original Issue	April 1, 2007

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Contents

1 General Information

1.1 Purpose

The purpose of this procedure is to document acceptable practices in the use of multiparameter data sondes in the monitoring of in situ water quality parameters and dye tracer.

1.2 Scope/Application

This procedure covers the use of multiparameter data sondes for monitoring of in situ water quality including real-time measurement, profiling, and unattended data logging. In situ water quality parameters may include dissolved oxygen (DO), temperature, pH, conductivity, turbidity, and chlorophyll. This procedure also applies to use of data sondes for monitoring dye tracer.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 Precautions

1.4.1 Safety

Equipment must be handled in a safe manner. Safety issues related to calibration or measurement of a specific parameter are addressed in individual parameter procedures. In addition, safety precautions should be followed in the deployment of data sondes. For unattended deployment in wadeable systems, data sondes should only be deployed and retrieved under safe flow/stage conditions. When deploying from a bridge, an amber flashing light should be operated on the roof of the field vehicle. When deploying from a boat, standard boating safety procedures should be followed. The SESD Safety, Health and Environmental Management Program Procedures and Policy Manual, provides more information regarding field safety.

1.4.2 Equipment Handling

To ensure the safe and reliable operation of equipment, the manufacturers' directions for transport, cleaning, decontamination, storage, and operation shall be followed. In general, upon return from the field and applicable data

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downloading, the batteries should be removed from the data sonde and the sonde washed via light brushing in warm, soapy water. Each probe should be cleaned and stored as directed by the manufacturer.

Prior to use, data sondes should be signed out in the instrument log book according to SESD Operating Procedure for Equipment Inventory and Management (SESDPROC-108). When unattended deployment is anticipated, pingers should be attached to the sonde, as feasible, to aid in recovery should the sonde be displaced during deployment.

1.4.3 Calibration

Prior to use, each sonde probe should be calibrated according to the specific parameter measurement procedure. However, because the sonde is a multi-probe unit, additional care must be taken to prevent cross-contamination of calibration standards. Similarly, calibration of multiple sonde units requires cross-contamination prevention procedures. Specifically, following immersion of the sonde probes into each calibration standard, all probes should be thoroughly rinsed in distilled or de-ionized water and the excess water shaken off or blotted dry with a lint-free wipe. Conductivity standards are much more sensitive to cross contamination/dilution than other standards; therefore, prior to immersion in a conductivity standard, all probes should be thoroughly rinsed and completely dried with lint-free wipes or compressed air. The conductivity probe on the sondes provides a linear reading of conductivity across the scale, so it is no longer necessary, as in some older technology meters, to calibrate with a standard close to what one may expect in the field. Therefore, due to the propensity of the standard to be easily diluted, one should use a relatively high concentration standard (typically in the 10,000 umho range) for conductivity calibrations.

Besides being easily diluted, conductivity also affects other parameters (specifically DO), therefore conductivity should always be the first parameter calibrated. The recommended order for calibration of the individual probes on a multiparameter sonde is as follows:

1. Conductivity
2. pH
3. DO
4. Turbidity/Chlorophyll/Rhodamine in any order

Rhodamine and Chlorophyll probes are calibrated in a similar fashion to turbidity. Specifically, the zero level is set using DI or distilled water followed by calibration to a known standard (typically 100 ppb for Rhodamine).

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1.5 References

SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Measurement of Dissolved Oxygen, SESDPROC-106, Most Recent Version

SESD Operating Procedure for Field pH Measurement, SESDPROC-100, Most Recent Version

SESD Operating Procedure for Field Specific Conductance Measurement, SESDPROC-101, Most Recent Version

SESD Operating Procedure for Field Turbidity Measurement, SESDPROC-103, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

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2 Methodology

2.1 General

With multiple probe options and customizable configuration, data sondes are extremely versatile tools for the measurement of in situ water quality. Effective use of multi-parameter sondes takes additional planning and procedures beyond those described in the individual operating procedures for each parameter (i.e., DO measurement, pH measurement, etc.).

Data sondes may be operated and/or programmed via the manufacturer's display unit or a laptop computer. In either case, it is recommended that the user take the manufacturer's applicable User Manual in the field should difficulties be encountered. If the display unit does not have a power indicator, the batteries should be checked or the unit charged, as applicable, prior to use. Power to the sonde may be supplied by the display unit or by the internal batteries installed in the sonde (a setting on the display unit menu). If the sonde is being powered by the display unit, it is possible to calibrate and set up the sonde for unattended deployment, when in fact there are no batteries in the sonde (the battery voltage being read is for the display unit and not for the sonde). Therefore, it is very important to insure that there are actually batteries in the sonde. Calibration and setting up for an unattended deployment use very little battery power, therefore, it is recommended that sondes be powered from their own internal batteries and not from the display unit. New alkaline or freshly charged nickel metal hydride (NMiH) batteries should be installed in each sonde prior to each field study. Generally, if the sondes will be deployed on multiple occasions during a field study, new alkaline batteries should be installed when the sonde voltage falls below 11.5 volts at end check. Nickel metal hydride (NMiH) batteries operate at a lower voltage than alkaline (1.2 volts vs. 1.5 volts); therefore, if using rechargeable batteries, they should be recharged or replaced if voltage falls below 10.5 volts.

Specific units require that, for the parameters of interest, the appropriate sensor be enabled via the display or laptop prior to use. The field investigator should follow manufacturer's procedures to ensure all required probes are functioning. If a particular parameter is not needed, the sensor should be turned off, via the menu, in order to conserve battery power. It should be noted that turning the reporting of the parameter off does not turn off the probe, it simply turns off the display of the parameter (the parameter is still being logged). One must go into the "Sensor" menu to actually turn off the sensor.

2.2 Real-time Monitoring

Real-time monitoring entails observing monitoring data via display unit or laptop computer as data is collected by the sonde. This data may be recorded in a field log book or logged to the internal memory of the sonde if so equipped. Logged data should be downloaded to a laptop or desktop computer as soon as possible. It is also recommended that download files be backed up in a separate location (USB thumb drives work very well for this). In addition, even when logging data at regular intervals, it is recommend

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for real-time monitoring that data also be recorded in a field log book at some, likely less frequent, interval to ensure that some data is captured should the instrument logger fail.

Real-time monitoring generally involves hand-held deployment or attachment to a stationary object at the monitoring location. Hand-held deployments are useful for short-term monitoring in small, wadeable streams. For longer monitoring periods or to hold the sonde at a specific depth, attachment to a fixed object may be more effective. Fixed objects may include rocks or embedded logs already in place at the site or may include fence posts or rods placed by the field investigator prior to monitoring. Sondes may also be hung at desired depths from a boat on larger water bodies.

2.3 Profiling

Profiling involves real-time monitoring or individual measurements at several depths through a water column. Profiling is especially useful for documenting water column gradients or stratification of in situ parameters or for evaluating complete mix conditions in dye tracer studies. Profiling deployments are generally conducted by hand to provide the movement of the sonde through the water column; however, profiling can also be conducted using mechanical/ electrical wench or reel type devices. In profiling applications, the profiling cable should be labeled in some manner to indicate depth or the sonde calibrated for depth. In general, profiling data is recorded in a field log book along with the location and depth information for each measurement.

In fast moving waters it may be necessary to attach weight to the sonde. Weights should always be attached to the probe guard or sonde body, not the individual probes. If attached to the probe guard, weights should be secured in such a way that the weights and attachments do not interfere with probe operation. In all real-time and profiling applications, especially when the sonde is weighted, it is important to ensure that the profiling cable is securely attached to the baling harness of the sonde to prevent a disconnection of the sonde and potential loss or damage to the sonde.

It is important to note that SESD has two general type of sondes, vented and non-vented. Each type of sonde has its own profiling cable. The difference is how the depth sensor works. Non-vented sondes have a standard pressure or depth sensor that can be zeroed out at the site and will then accurately measure depth, typically to within a half a foot or less. Vented sondes have a small hole in the center of the connector pins where the cable attaches and are typically used to accurately (+/- 0.01 feet) measure changes in water stage level in unattended deployments, but may also be used for profiling applications. In order for a vented sonde to accurately measure depth or stage, the sonde MUST be used with a vented cable which vents to the atmosphere. If a vented sonde is used with a vented cable, just zero the depth at the site and measure depth as with a non-vented sonde If a vented sonde is used with a non-vented cable it will NOT give accurate depth readings. Also, since vented sondes are typically used for stage measurements, the depth sensor is only rated to a maximum depth of 30 feet, whereas non-vented sondes are typically rated to 200 feet.

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2.4 Unattended Deployment

Unattended deployment entails pre-programming and deployment of a sonde at a specific location to log monitoring data in the absence of observation by a field investigator. Unattended deployments are useful for collecting data at regular intervals over extended monitoring periods, frequently up to 3 – 4 days. However, since no data are recorded by hand during the deployment, it is critical that the sonde be correctly programmed.

Programming of the sonde should follow the manufacturer's procedures for unattended deployment. The sonde may be programmed in the lab prior to a field study or programmed in the field. Programming of the sonde is typically accomplished either by the sonde's display unit or by laptop computer. Programming requires input of a start data/time, deployment duration, data log file name, and monitoring interval. Programming times should always be input in local time for the study area, unless otherwise noted in the field log. The field log book should also include the sonde identifier, the date/time of initial deployment, date/time of retrieval, deployment location, and sonde depth. Similarly, recorded times should be in local time for the study area.

In addition to enabling the required probes as described in Section 2.1, some units further require identification of the parameters to include in the logged data file. The field investigator should follow manufacturer's procedures to ensure all necessary data will be successfully logged.

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U.S. Environmental Protection Agency
Region 4, Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Measurement of Oxidation-Reduction Potential (ORP)**

Effective Date: August 7, 2009	**Number:** SESDPROC-113-R0

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Revision History

This Table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-113-R0, *Field Measurement of Oxidation-Reduction Potential (ORP)*, Original Issue	August 7, 2009

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1 General Information

1.1 Purpose

This document describes procedures, methods and considerations to be used and observed when conducting field Oxidation-Reduction Potential (ORP) measurements in aqueous environmental media, including groundwater, surface water and certain wastewater. The measurement of soil ORP is a non-standard measurement and procedures should be developed on a project-specific basis.

1.2 Scope/Application

This document describes procedures generic to all ORP measurement methods to be used by Science and Ecosystem Support Division (SESD) field personnel when collecting and handling samples in the field. On the occasion SESD personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to obtain an ORP measurement, the variant procedure will be documented in the field book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and has been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the SESD LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

Faulkner, S.P., W.H. Patrick, Jr., and R.P. Gambrell. 1989. Field techniques for measuring wetland soil parameters. Soil Sci. Soc. Am. J. 53:883-890.

Megonigal, J.P., W.H. Patrick, Jr., and S.P. Faulkner. 1993. Wetland identification in seasonally flooded forest soils: soil morphology and redox dynamics. Soil Sci. Soc. Am. J. 57:140-149.

D.K. Nordstrom and F.D. Wilde. 2005. National Field Manual, Chapter A6, Section 6.5: Reduction Oxidation Potential (Electrode Method). USGS.

Pankow, J.E. 1991. Aquatic chemistry concepts. Lewis Publishers, Inc. Cheleas, Michigan. USA.

Pruitt, B.A. 2001. Hydrologic and soil conditions across hydrogeomorphic settings. Dissertation. The University of Georgia, Athens, GA. USA.

Soil Survey Staff. 1998. Keys to soil taxonomy, 8th Edition. United States Department of Agriculture, Natural Resources Conservation Service, Washington, DC. USA.

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Standard Methods. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. Prepared and published jointly by: American Public Health Association, American Water Works Association, Water Environment Federation. American Public Health Association, Washington, DC. USA.

Stumm, W. and J.J. Morgan. 1981. Aquatic chemistry: an introduction emphasizing chemical equilibra in natural waters, 2nd Ed. John Wiley & Sons, New York. USA.

USEPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division, Athens, GA.

USEPA. 2007. Safety, Health and Environmental Management Program Procedures and Policy Manual. Science and Ecosystem Support Division, Region 4, Athens, GA.

Wikipedia entry. Reduction Potential. http://en.wikipedia.org/wiki/Reduction_potential. Retrieved April 2, 2009.

1.5 General Considerations

1.5.1 Safety

Proper safety precautions must be observed when verifying or calibrating instruments for measurement of Oxidation-Reduction Potential.. Refer to the SESD Safety, Health and Environmental Management Program Procedures and Policy Manual (USEPA 2007) and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional.

Reagents commonly used in the preparation of ORP calibration standards are toxic and require care when handling. When using this procedure, avoid exposure to these materials through the use of protective clothing, eye wear and gloves. Safety precautions when handling and preparing verification solutions should include gloves and eyewear to prevent dermal and eye contact, and a mask to avoid inhaling dust particles when handling dry materials. Vigorous flushing should be used if the reagents or solutions come in contact with skin or eyes. Following is specific information on commonly used solutions. The application of the solutions is described in detail in the 3.1.1 Calibration Solutions section of this procedure.

Quinhydrone (CAS# 106-34-3) is a skin and respiratory irritant and is poisonous if ingested. Safety precautions when handling quinhydrone should include gloves to prevent dermal contact and a mask to avoid inhaling dust particles when mixing dry material to prepare calibration standards. Vigorous flushing should be used if concentrated material comes in contact with skin or eyes.

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Zobell's solution is also an irritant and toxic if ingested. The same handling precautions apply when mixing and using Zobell's solution as when using quinhydrone. Zobell's reacts with acid to form harmful byproducts, including hydrocyanide gas.

Light's solution contains ferro- and ferric-cyanide compounds in sulfuric acid. The components are toxic and burns are possible from contact with this solution.

Potassium Iodide solutions have lower toxicity than most calibration solution options. General ingestion, skin contact, and eye contact precautions apply.

Unused quinhydrone, Zobell's, Light's or other calibration reagents and solutions should be returned to SESD for disposal per the SESD Safety, Health, and Environmental Management Plan (SHEMP).

1.5.2 Records

Documentation of field activities is done in a bound logbook. All records, including a unique, traceable identifier for the instrument, should be entered according to the procedures outlined in the SESD Operating Procedure for Logbooks (SESDPROC-010) and the SESD Operating Procedure for Equipment Inventory and Management, (SESDPROC-108).

All field ORP measurements pertinent to the sampling event should be recorded in the field log book for the event as outlined in the SESD Operating Procedure for Logbooks (SESDPROC-010), or managed electronically with appropriate backups as described in SESD Operating Procedure for Control of Records, SESDPROC-002.

1.5.3 Shipping

Shipped material shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.

All shipping documents, such as bills of lading, will be retained by the project leader and stored in a secure place.

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2 Background

2.1 General

Oxidation is the process of liberating electrons or gaining oxygen. Examples of oxidation include conversion of elemental iron to rust, elemental sulfur to sulfate, and elemental hydrogen to water (Pankow 1991). Reduction is the process of gaining electrons resulting in the charge on some atomic unit in the species to be reduced. Oxidation-reduction potential (ORP) or redox potential (hereafter, referred to as redox) is a measure of the intensity or activity of an aqueous environment or soil to mediate reactions of important elements in biological systems (e.g., O, N, Mn, Fe, S, and C) and other metallic elements.

Considerable confusion arises on the use of the terms oxidation and reduction as they apply to the media under study. The following introduction reproduced from an online 'Wikipedia' article on the topic lucidly explains their relationship in ORP measurement:

> **Reduction potential** (also known as **redox potential, oxidation / reduction potential** or **ORP**) is the tendency of a chemical species to acquire electrons and thereby be reduced. Each species has its own intrinsic reduction potential; the more positive the potential, the greater the species' affinity for electrons and tendency to be reduced.
>
> In aqueous solutions, the reduction potential is the tendency of the solution to either gain or lose electrons when it is subject to change by introduction of a new species. A solution with a higher (more positive) reduction potential than the new species will have a tendency to gain electrons from the new species (i.e. to be reduced by oxidizing the new species) and a solution with a lower (more negative) reduction potential will have a tendency to lose electrons to the new species (i.e. to be oxidized by reducing the new species). Just as the transfer of hydrogen ions between chemical species determines the pH of an aqueous solution, the transfer of electrons between chemical species determines the reduction potential of an aqueous solution. Like pH, the reduction potential represents an intensity factor. It does not characterize the capacity of the system for oxidation or reduction, in much the same way that pH does not characterize the buffering capacity.

In short, a numerically positive redox potential or ORP represents an environment conducive to the oxidation of an introduced substance by reduction of the original media.

2.2 Instrumentation

ORP measurement systems are a practical implementation of electrochemical cells, which use metal electrodes in a solution to generate an electric current or voltage. If a platinum electrode is immersed in water with hydrogen bubbled into the solution, the H^2 is oxidized as follows:

$$H^2 = 2H^+ + 2e^-$$

In the electrochemical half-cell illustrated below in Fig.1, hydrogen gas oxidizes to hydrogen ions and free electrons, comprising an oxidation-reduction couple. This couple reaches an

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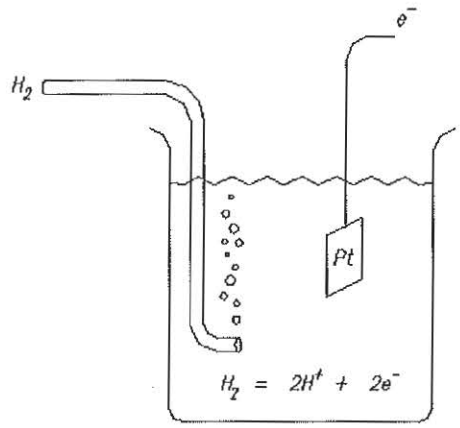
equilibrium state that maintains the reference potential of the electrode. The electric potential develops on the wire connected to the platinum electrode, but is difficult to measure in practice in the isolated half-cell. However, when used in a complete electrochemical cell, the cell illustrated is used as a reference to measure other half-cells against, and is called a Standard Hydrogen Electrode (SHE).

Figure 1.



Hydrogen Half-Cell

If, as shown in Figure 2, a SHE is connected with a salt bridge to a second half-cell in which a reduction reaction is taking place, the electric potential between the two cells can be measured. In the case shown, the potential of the right cell will be +0.34 Volts in reference to the standard hydrogen electrode on the left. This would be represented as an Oxidation Reduction Potential (ORP) of +340mV on the hydrogen scale, or simply as Eh = +340mV.

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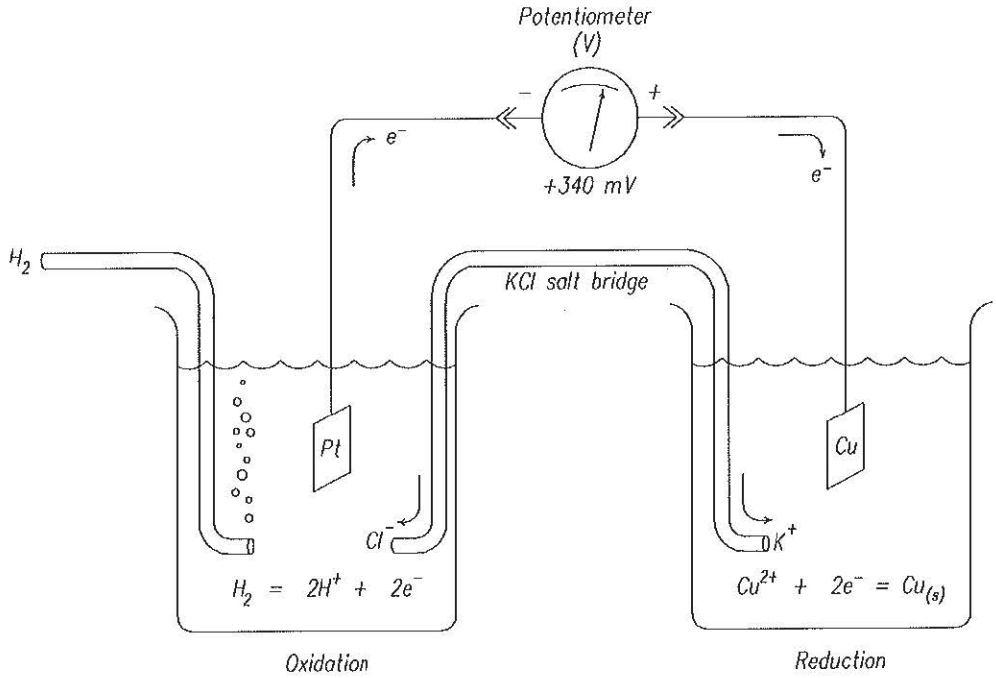
Figure 2.



In field practice, the hydrogen electrode is difficult to reproduce. To conduct field measurements, a reference electrode is needed that is simple to maintain and will generate a potential that can be referenced to the standard hydrogen electrode. These requirements are met by the Saturated Calomel Electrode (SCE) and the Silver/Silver Chloride Electrode (SSCE - the SSCE is also commonly identified as an Ag/AgCl electrode). The SCE contains a small amount of elemental mercury, and while useful for certain applications, would rarely be used at SESD. The SSCE or Ag/AgCl electrode is generally used as the reference cell in SESD instrumentation.

In Figure 3 below, a SHE is connected to an Ag/AgCl electrode. In this example of an electrochemical cell, both cells reach an equilibrium potential. At that equilibrium state, the potential of the Ag/AgCl cell is 220mV more positive than the standard hydrogen electrode.

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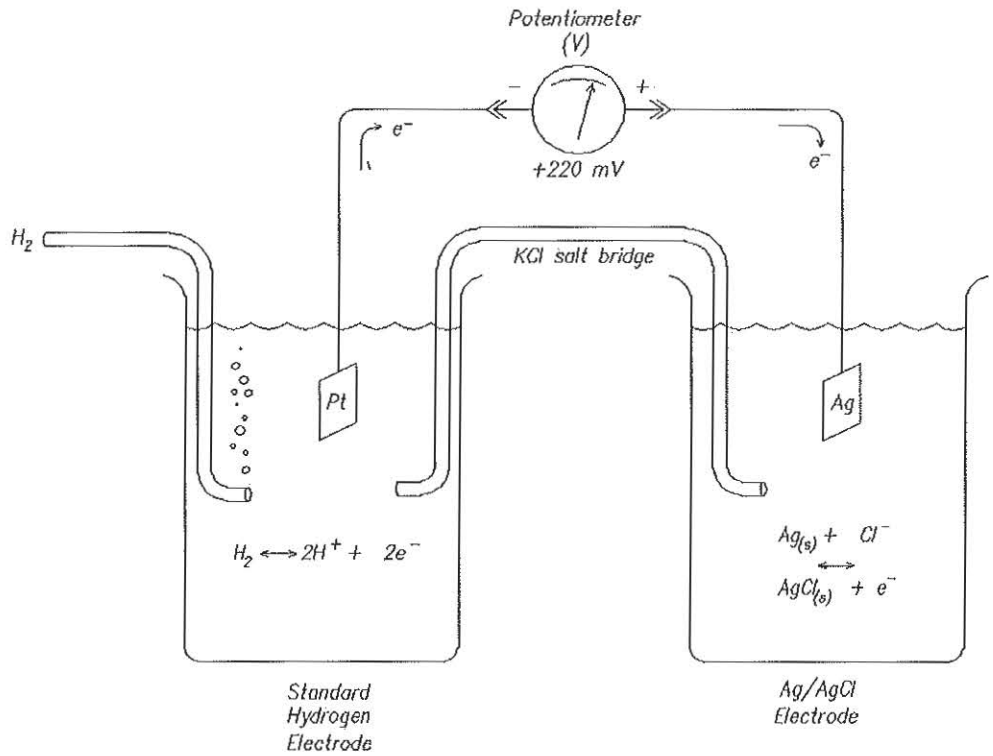
Figure 3.



This half-cell potential of the Ag/AgCl electrode in reference to the SHE is used to convert measurements taken with an Ag/AgCl reference back to the hydrogen scale. While the laboratory Ag/AgCl half-cell shown has a potential of +220mV, practical reference cells have varying potentials based on temperature and filling solutions as shown in Table 1 below.

Table 1.

Half-cell Potential of Ag/AgCl reference electrode

derived from USGS NFM, Table 6.5.2 (9/2005)

	Molarity of KCl filling solution			
T(°C)	3M	3.3M*	3.5M	Sat/4M
10	220	217	215	214
15	216	214	212	209
20	213	210	208	204
25	209	207	205	199
30	205	203	201	194
35	202	199	197	189
40	198	195	193	184

*interpolated value

Note: YSI sondes and Thermo electrodes typically use 4M KCl filling solutions. Eureka sondes typically use 3.3M KCl filling solutions

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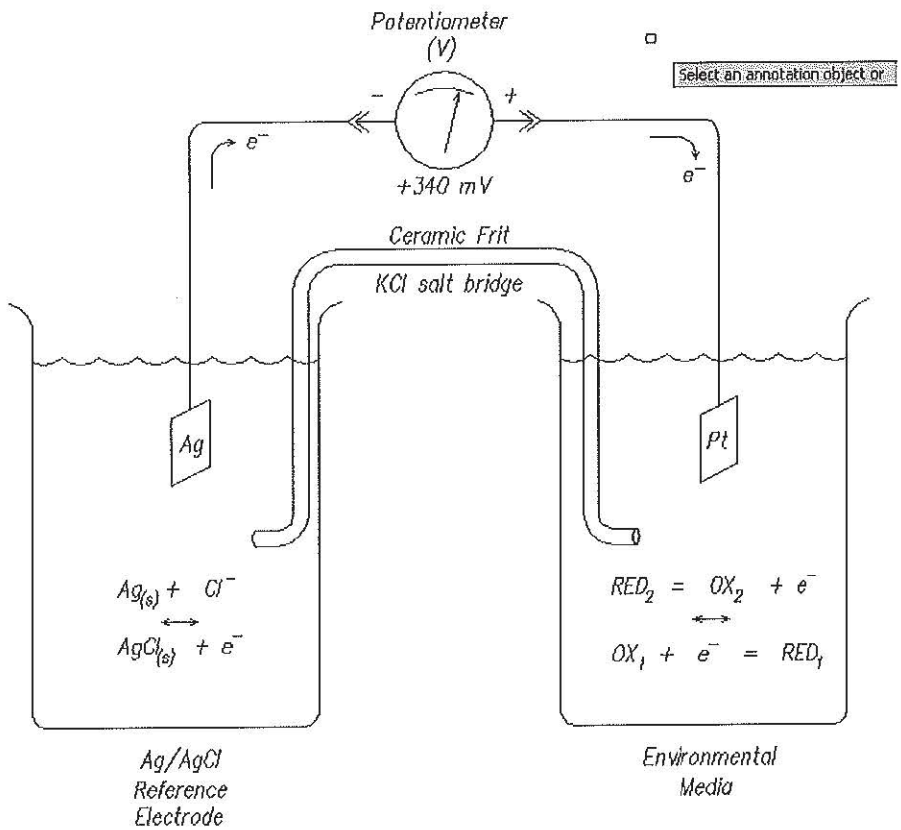
In Figure 4 below, an actual field instrument is represented as separate electrochemical cells. The Ag/AgCl reference electrode uses a ceramic frit or other means to provide the essential salt bridge to the environmental media. In multi-parameter sondes, the reference electrode is typically shared by the ORP and pH measuring systems. The platinum electrode is immersed in the environmental media and connected internally in the instrument to measure the potential (voltage) between the two electrodes.

Figure 4.



In this illustration, an ORP is measured of 340 mV. This measurement is made in reference to the Ag/AgCl reference electrode and would be reported as such, or as $E_{Ag/AgCl}$ = 340mV.

In many cases it will be desirable to report the reading on the hydrogen scale, or Eh. To do so, the potential of the reference electrode against the SHE, as obtained in Figure 3, is added to $E_{Ag/AgCl}$. For our example:

	340 mv	Measured ORP ($E_{Ag/AgCl}$) of sample
+	220 mV	Eh of Ag/AgCl electrode (ORP of Ag/AgCl electrode referenced to SHE)
	560 mV	Eh of sample

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Both the +340 mV field reading and the corrected +560 mV Eh can properly be referred to as ORP results. It is only through specifying the reference scale that the ambiguity can be eliminated.

2.2 Redox Chemistry

In acid-base chemistry, the pH of a system is defined as the negative logarithm of the hydrogen ion activity (simplified in practice to the hydrogen ion concentration):

$$pH = -\log \{H^+\}$$

Similarly, Pankow (1991) described the negative logarithm of the electron activity (pe) as the master variable for describing the equilibrium position for all redox couples in a given system:

$$pe \equiv -\log \{e^-\}$$

It can be shown (Pankow) that pe is related to Eh by

$$Eh = pe*(2.303*R*T)/F$$

Where:

R = gas constant = $8.314\ J\ K^{-1}\ mol^{-1}$
T = temperature, °K
F = Faraday constant = $96.485*10^3\ C\ mol^{-1}$

At 25°C (298°K) this simplifies to

$$E_H = pe * 0.05916$$

And

$$pe = E_H / 0.05916$$

According to Faulkner et al. (1989) redox is a quantitative measure of electron availability and is indicative of the intensity of oxidation or reduction in both chemical and biological systems. When based on a hydrogen scale, redox (E_H) is derived from the Nernst Equation (Stumm and Morgan 1981):

$$E_H = E_H^o + 2.3 \times (R \times T)/nF \times \log (\prod_i \{ox\}^{ni}/\prod_j \{red\}^{nj}) \qquad (2)$$

where
E_H^o = potential of reference, mV
R = gas constant = $81.987\ cal\ deg^{-1}\ mole^{-1}$
T = temperature, °K
n = number of moles of electrons transferred
F = Faraday constant = 23.061 cal/mole-mv
{ox} and {red} = activity of the oxidants and reductants, respectively

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2.3 Applications

When interpreted properly, redox combined with other conventional water quality parameters is useful in developing a more complete understanding of water chemistry. Several applications of redox are identified below:

1. Redox could be viewed as an extension of the oxygen scale. In this model, the DO probe spans the aerobic scale and the redox probe extends that scale to measure anaerobic conditions. Inferences to geochemistry and chemical speciation can be made from the oxidative state of the system. Application to metal sequestration, metal-iron, -sulfide, -methane complexation, and the subsequent bioaccumulation potential is possible.
2. Redox can be used to identify anaerobiosis at or near the water column and sediment interface in streams, lakes, and estuaries.
3. Redox may be useful in determination of stream jurisdiction and wetland delineation in that it can indicate conditions of soil saturation.
4. Based on redox, a pe (or EH) vs. pH stability diagram can be developed to aid in nutrient exchange studies including the timing, release, and partitioning of important water and sediment quality pollutants such as nitrogen and phosphorus species. Most importantly, redox can be used to address error associated with chamber-effect during closed chamber measurements of the water-sediment interface. Redox probes placed inside the contact chamber and inserted approximately ten centimeters into the underlying sediment can be used to monitor changes in sediment redox caused by the chamber, and steps can be taken to reduce chamber-effect.
5. Redox may be useful in establishing water and sediment quality standards applicable to wetlands.
6. Redox is used to assess the potential of a groundwater system to support various insitu reactions with contaminants, such as reductive dechlorination of chlorinated solvents.
7. Redox can provide a useful indicator of conditions that might compromise the performance of Clark-type dissolved oxygen (DO) probes. In general, anaerobic conditions occur at a redox range of +150 mV to +300 mV (pH-dependent and adjusted to hydrogen reference electrode). When redox drops below this level, DO measurements as determined with a Clarke-type probe are highly suspect as the semi-permeable membrane does not discriminate between partial O_2 and sulfides. Consequently, the meter may be reading sulfides.

2.4 Limitations

In most environmental media, redox reactions will not reach equilibrium due to low concentrations or multiple redox species. Consequently, redox measurements can generally be considered semi-quantitative in environmental media, unless certain conditions exist.

The USGS in the Interferences and Limitations Section 6.5.3A of their National Field Manual succinctly describe some of the issues encountered in the application of ORP measurements. This section is reproduced here, unedited:

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6.5.3.A INTERFERENCES AND LIMITATIONS

Measurements should not be carried out without an awareness of the interferences and limitations inherent in the method.

- *Organic matter and sulfide may cause contamination of the electrode surface, salt bridge, or internal electrolyte, which can cause drift or erratic performance when reference electrodes are used (American Public Health Association and others, 2001).*
- *Hydrogen sulfide can produce a coating on the platinum electrode that interferes with the measurement if the electrode is left in sulfide-rich water for several hours (Whitfield, 1974; Sato, 1960).*
- *The platinum single and combination redox electrodes may yield unstable readings in solutions containing chromium, uranium, vanadium, or titanium ions and other ions that are stronger reducing agents than hydrogen or platinum (Orion Research Instruction Manual, written commun., 1991).*
- *Do not insert redox electrodes into iron-rich waters directly after the electrode(s) contact ZoBell's. An insoluble blue precipitate coats the electrode surface because of an immediate reaction between ferro- and ferricyanide ions in ZoBell's with ferrous and ferric ions in the sample water, causing erratic readings.*

Many elements with more than one oxidation state do not exhibit reversible behavior at the platinum electrode surface and some systems will give mixed potentials, depending on the presence of several different couples (Barcelona and others, 1989; Bricker, 1982, p. 59–65; Stumm and Morgan, 1981, p. 490–495; Bricker, 1965, p. 65). Methane, bicarbonate, nitrogen gas, sulfate, and dissolved oxygen generally are not in equilibrium with platinum electrodes (Berner, 1981).

TECHNICAL NOTE:

Misconceptions regarding the analogy between Eh (pe) and pH as master variables and limitations on the interpretation of Eh measurements are explained in Hostettler (1984), Lindberg and Runnells (1984), Thorstenson (1984), and Berner (1981). To summarize:

(1) Hydrated electrons do not exist in meaningful concentrations in most aqueous systems—in contrast, pH represents real activities of hydrated protons. Eh may be expressed as pe (the negative logarithm of the electron activity), but conversion to pe offers no advantage when dealing with measured potentials.

(2) Do not assume that redox species coexist in equilibrium. Many situations have been documented in which dissolved oxygen coexists with hydrogen sulfide, methane, and ferrous iron.

- *The practicality of Eh measurements is limited to iron in acidic mine waters and sulfide in waters undergoing sulfate reduction.*
- *Other redox species are not sufficiently electroactive to establish an equilibrium potential at the surface of the conducting electrode.*

(3) A single redox potential cannot be assigned to a disequilibrium system, nor can it be assigned to a water sample without specifying the particular redox species to which it refers. Different redox elements (iron, manganese, sulfur,

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selenium, arsenic) tend not to reach overall equilibrium in most natural water systems; therefore, a single Eh measurement generally does not represent the system.

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3 Methodology

3.1 Standard solutions

Care should be taken not to contaminate standards and samples and to verify the expiration date of all standards prior to use. All meters should be verified or calibrated according to the manufacturer's procedures.

Standard solutions for calibration and verification should be selected to meet project requirements. SESD generally maintains a stock of Zobell's solution suitable for most projects. The characteristics and use of the common standard solutions are described below.

Zobell's solution contains potassium ferri- and ferro- cyanide compounds. The solution is available as prepared solutions or premeasured reagents for mixing by the user. Zobell's has moderate toxicity but will react with acid to form harmful byproducts, including hydrocyanide gas. It has a shelf life ranging from several days to several months depending on the manufacturer. Stock and working solutions of Zobell's should be stored in dark bottles due to its light sensitivity.

Quinhydrone solutions are mixed at the time of use by adding quinhydrone to pH4 or pH7 buffers. At 25°C, the E_h of quinhydrone pH4 and pH7 verification solutions are 462mV and 285mV respectively. An advantage of quinhydrone solutions is that they offer a span of calibration points that may be appropriate for particular applications. Quinhydrone is a lightly 'poised' solution in that it offers less driving force towards the calibration point: a compromised instrument is more likely to be revealed in a quinhydrone calibration. A quinhydrone calibration/verification solution is created by adding 10g of quinhydrone to 1L of ph4 or pH7 buffer solution (ASTM D1498). The solutions are mixed on a magnetic mixing plate for a minimum of 15 minutes to create a saturated solution with undissolved crystals remaining. Quinhydrone solutions are usable for 8hrs from the time of mixing.

Light's solution consists of ferrous and ferric ammonium sulphate in sulphuric acid. The solution would rarely be used at SESD due to its high acidity and associated handling difficulty. Spent solutions with a pH<2 would be regulated as a hazardous waste. Light's is a highly poised solution that may allow a marginally functioning electrode to pass calibration.

A prepared potassium iodide solution is available which has low toxicity and a long shelf life. The solution may stain clothing or surfaces if spilled.

3.2 Verification and Calibration

ORP instruments may be **verified** or **calibrated**, depending on the application. The approach chosen should be selected based on project needs and information presented in the 2.4 Limitations section of this procedure. Standard laboratory practice in making ORP measurements is to **verify** the accuracy of the instrument prior to use, and this practice should be

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followed when true quantitative results are required. In a **verification** the instrument in its direct-reading mode is checked against a standard solution in a pass/no-pass test, and no corrections are applied to subsequent measurements. In most applications, the ORP information is used semi-quantitatively and for these applications, the instruments may be **calibrated** to the standard solutions. In an instrument **calibration**, the instrument probe is placed in the standard solution and the difference between the standard measurement and the known ORP value of the standard is used by the instrument to make adjustments to the subsequent measurements.

In **verification** of an ORP instrument, the instrument is set to absolute mV reading mode or the internal calibration offset is zeroed out. The instrument probe should then be placed in the standard solution and the reading verified to fall within +/-10mV of the predicted reading for the standard. Instruments with single-purpose electrodes are most suitable for this approach. If the instrument fails the verification, standard solution quality should be considered and instrument maintenance performed per the manufacturer's procedures.

In most SESD field practice, the end data use is semi-quantitative. In this case, the instruments can be **calibrated** to standard solutions appropriate for the project using the manufacturer's recommended procedure. One minute after the calibration, the instrument should display a stable reading within +/-10mV of the predicted reading. An instrument failing this test should be recalibrated to determine if the problem is inadequate equilibration time. In the event of continued instrument failure, aging or contamination of the standard solution should be considered. Subsequently the electrode should be serviced according to the manufacturer's procedures. Common service procedures include cleaning the platinum electrode with mild abrasives or acids and refilling or replacing the reference electrode.

Prior to a mobilization, all ORP instruments will be checked for proper operation and verified or calibrated against standard solutions. During the field mobilization, each instrument will be calibrated or verified prior to, and verified after, each day's use or deployment.

The predicted ORP values of standard solutions will be obtained from the manufacturer of prepared solutions, literature, or appropriate values listed in this procedure. Care is in order, as the predicted ORP value is specific for the type of reference electrode used by the probe (either Ag/AgCl or calomel) and the molarity of the filling solution in the reference electrode. To use the solution with another electrode or filling solution, the expected ORP readings for the solution should be converted to Eh for the probes intended for the solution as per the Reporting section of this procedure. Then a table can be compiled for the electrode in use by subtracting the $E_{h,ref}$ for the electrode and filling solution in use. This will be done at the Field Equipment Center (FEC) for the solutions stocked.

Verification solutions should be managed per the manufacturer's directions regarding storage and handling. After instrument verification or calibration, the solution cannot be returned to the stock solution container, although a separate container of working solution can be maintained.

Spent solutions and working solutions should be returned from the field to the SESD laboratory for proper disposal by the SHEMP. Properly handled stock solutions may be returned to the FEC for use at that facility.

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3.3 Measurement

ORP measurements should be conducted in a fashion that prevents the addition or loss of any potential oxidants or reductants. Results could be compromised by exposing the sample to air or allowing H_2S to off-gas from anoxic samples. Like dissolved oxygen measurements, ORP measurements should be conducted insitu or by using a flow-through cell evacuated of air (see Field Measurement of Dissolved Oxygen (SESDPROC-106).

When using multi-parameter probes for ORP measurements, the general guidelines for probe deployment described in Field Measurement of Dissolved Oxygen (SESDPROC-106) and Insitu Water Quality Monitoring (SESDPROC-111) apply.

ORP probes must be operated and maintained in accordance with the manufacturer's instructions. Reference electrodes in multi-parameter probes may require regular filling or replacement. Single parameter ORP electrodes may require regular filling and operation in an upright position to assure that proper salt bridge flow is maintained. Platinum electrode surfaces are easily contaminated and polishing or cleaning of the electrodes should be performed as recommended by the manufacturer.

Measurements in field logbooks should be recorded to the nearest mV. The type of reference electrode in use and its filling solution should be recorded in at least one logbook as part of the field project records.

ORP is a temperature sensitive measurement, but ORP instruments are not temperature compensated. Consequently, the media temperature should always be recorded at the same time as the ORP is recorded. Likewise, as ORP is often pH dependent, pH should also be recorded at the time of ORP measurement.

3.4 Reporting

In the absence of a specified reference scale, ORP data has no meaning. Therefore, the reference scale used should always be specified in reporting or discussing the ORP data. ORP measurements converted to a hydrogen scale can be reported as "E_h". Data reported as the direct field measurement without correction might be described as "ORP referenced to Ag/AgCl electrode" or "$E_{Ag/AgCl}$". The expectations of the data user should be ascertained or the measurements should be reported in both systems.

To apply corrections to obtain E_h from the direct field measurement, the known half-cell potential of the reference electrode is added to the recorded field ORP value:

$$E_{h,sample} = ORP_{sample} + \text{half-cell potential of reference electrode}$$

The following table, reproduced from Section 2.2, presents the half-cell potential of a silver/silver chloride reference electrode at various temperatures and with various molarities of KCl filling solutions.

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Table 1.

Half-cell Potential of Ag/AgCl reference electrode

derived from USGS NFM, Table 6.5.2 (9/2005)

	Molarity of KCl filling solution			
T(°C)	3M	3.3M*	3.5M	Sat/4M
10	220	217	215	214
15	216	214	212	209
20	213	210	208	204
25	209	207	205	199
30	205	203	201	194
35	202	199	197	189
40	198	195	193	184

*Interpolated value

Note: YSI sondes and Thermo electrodes typically use 4M KCl filling solutions. Eureka sondes typically use 3.3M KCl filling solutions

Example:

A multi-parameter probe with a silver/silver chloride reference electrode and 4M KCl filling solution is used to record a stream ORP measurement of 146mV. The stream temperature is recorded as 15°C.

From the above table, the half-cell potential of an Ag/AgCl reference electrode filled with 4M KCl is 209mV at 15°C. Then:

$$E_{h,sample} = ORP_{Ag/AgCl,sample} + \text{half-cell potential of Ag/AgCl reference electrode}$$

$$E_{h,sample} = 146mV + 209mV$$

$$E_{h,sample} = 355mV$$

As noted in the 3.3 Measurements section, ORP measurements are sensitive to temperature, and may be sensitive to pH. As the instruments do not compensate for these parameters, ORP data should always be reported with the temperature and pH of the media at the time of measurement.

Final reporting values of Eh or ORP should be rounded to the nearest 10mV. The following spreadsheet formula can perform the rounding of an interim result located in spreadsheet cell 'A1':

=INT(A1/10+0.5)*10

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Management of Investigation Derived Waste**

Effective Date: October 15, 2010	**Number:** SESDPROC-202-R2

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-202-R2, *Management of Investigation Derived Waste*, replaces SESDPROC-202-R1. **General:** Corrected typographical, grammatical and/or editorial errors. **Cover Page:** The Enforcement and Investigations Branch Chief was changed from Antonio Quinones to Archie Lee. The FQM was changed from Laura Ackerman to Liza Montalvo. **Revision History:** Changed Field Quality Manager to Document Control Coordinator. **Section 1.2:** Added the following statement: Mention of trade names or commercial products does not constitute endorsement or recommendation for use. **Section 1.3:** Omitted reference to the H: drive of the LAN. Changed Field Quality Manager to Document Control Coordinator. **Section 2, first bullet:** Replaced "personnel" protective equipment with "personal" protective equipment. **Table 1:** On the Hazardous/PPE-Reusable cell - Added the full reference to SESDPROC-205. On the Non-hazardous/Decontamination Water cell - Added a statement to reflect that decontamination water may also be disposed in a sanitary sewer system, with permission from the wastewater treatment plant representative, and if doing so does not endanger human health or the environment, or violate federal or state regulations. On the Non-hazardous/Disposable Equipment cell - Added a statement to reflect that, if unfeasible, this equipment could be returned to the FEC for disposal in the FEC's dumpster.	October 15, 2010
SESDPROC-202-R1, *Management of Investigation Derived Waste*, replaces SESDPROC-202-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch.	November 1, 2007

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Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	
SESDPROC-202-R0, Management of Investigation Derived Waste, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures and considerations to be used and observed when managing investigation derived waste (IDW) generated during the course of hazardous waste site investigations.

1.2 Scope/Application

The procedures and management options for the different categories of IDW described in this document are to be used by SESD field personnel to manage IDW generated during site investigations. On the occasion that SESD field personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used to manage IDW generated at a particular site, the variant procedure will be documented in the field logbook, along with a description of the circumstances requiring its use. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD Local Area Network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

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1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when managing IDW. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when managing IDW:

- Due to time limitations and restrictions posed by RCRA regulations on storage of hazardous waste, accumulation start dates should be identified on all drums, buckets or other containers used to hold IDW so that it can be managed in a timely manner.
- During generation of both non-hazardous and hazardous IDW, keep hazardous IDW segregated from non-hazardous IDW to minimize the volume of hazardous IDW that must be properly managed.

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2 Types of Investigation Derived Waste

Materials which may become IDW include, but are not limited to:

- Personal protective equipment (PPE) - This includes disposable coveralls, gloves, booties, respirator canisters, splash suits, etc.
- Disposable equipment and items - This includes plastic ground and equipment covers, aluminum foil, conduit pipe, composite liquid waste samplers (COLIWASAs), Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.
- Soil cuttings from drilling or hand augering.
- Drilling mud or water used for mud or water rotary drilling.
- Groundwater obtained through well development or well purging.
- Cleaning fluids such as spent solvents and wash water.
- Packing and shipping materials.

Table 1, found at the end of this procedure, lists the types of IDW commonly generated during field investigations and the current disposal practices for these materials.

For the purpose of determining the ultimate disposition of IDW, it is typically distinguished as being either hazardous or non-hazardous. This determination is based on either clear regulatory guidance or by subsequent analysis. This determination and subsequent management is the responsibility of the program site manager.

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3 Management of Non-Hazardous IDW

Disposal of non-hazardous IDW should be addressed in the study plan or QAPP for the investigation. To reduce the volume of any IDW transported back to the Field Equipment Center (FEC), it may be necessary to compact the waste into a reusable container, such as a 55-gallon drum.

If the waste is from an active facility, permission should be sought from the operator of the facility to place the non-hazardous PPE, disposable equipment, and/or paper/cardboard into the facility's dumpsters. If necessary, these materials may be placed into municipal dumpsters, with the permission of the owner. These materials may also be taken to a nearby permitted landfill. On larger studies, waste hauling services may be obtained and a dumpster located at the study site.

Disposal of non-hazardous IDW such as drill cuttings, drilling mud, purge or development water, decontamination wash water, etc., should be specified in the approved study plan or QAPP. It is recommended that these materials be placed into a unit with an environmental permit, such as a landfill or sanitary sewer. These materials must not be placed into dumpsters. If the facility at which the study is being conducted is active, permission should be sought to place these types of IDW into the facility's treatment system. It may be feasible to spread drill cuttings around the borehole, or, if the well is temporary, to place the cuttings back into the borehole. Non-hazardous monitoring well purge or development water may also be poured onto the ground down gradient of the monitoring well when site conditions permit. Purge water from private potable wells which are in service may be discharged directly onto the ground surface.

The minimum requirements for this subsection are:

- Non-hazardous liquid and soil/sediment IDW may be placed on the ground or returned to the source if doing so does not endanger human health or the environment or violate federal or state regulations. Under no circumstances, however, should monitoring well purge water be placed back into the well from which it came.
- Soap and water decontamination fluids and rinsates of such cannot be placed in any water bodies and must be collected and returned to the FEC for disposition.
- The collection, handling and proposed disposal method must be specified in the approved study plan or QAPP.

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4 Management of Hazardous IDW

Disposal of hazardous or suspected hazardous IDW must be specified in the approved study plan or QAPP for the study or investigation. Hazardous IDW must be disposed as specified in USEPA regulations. If appropriate, these wastes may be placed back in an active facility waste treatment system. These wastes may also be disposed in the source area from which they originated if doing so does not endanger human health or the environment.

If on-site disposal is not feasible, and if the wastes are suspected to be hazardous, appropriate tests must be conducted to make that determination. If they are determined to be hazardous wastes, they must be properly contained and labeled. They may be stored on the site for a maximum of 90 days before they must be manifested and shipped to a permitted treatment or disposal facility. Generation of hazardous IDW must be anticipated, if possible, to allow arrangements for proper containerization, labeling, transportation and disposal/treatment in accordance with USEPA regulations.

The generation of hazardous IDW should be minimized to conserve Division resources. Most routine studies should not produce any hazardous IDW, with the possible exception of spent solvents and, possibly, purged groundwater. The use of solvents during field cleaning of equipment should be minimized by using solvent-free cleaning procedures for routine cleaning and decontamination (see SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205). If solvents are needed, the volume should be minimized by using only the amount necessary and by capturing the residual solvent separately from the aqueous decontamination fluids (detergent/wash water mixes and water rinses).

At a minimum, the requirements of the management of hazardous IDW are as follows:

- Spent solvents must be left on-site with the permission of site operator and proper disposal arranged.
- All hazardous IDW must be containerized. Proper handling and disposal should be arranged prior to commencement of field activities.

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Table 1: Disposal of IDW

TYPE	HAZARDOUS	NON - HAZARDOUS
PPE-Disposable	Containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.
PPE-Reusable	Decontaminate as per SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, if possible. If the equipment cannot be decontaminated, containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Decontaminate as per SESDPROC-205, and return to FEC.
Spent Solvents	Containerize in original containers. Clearly identify contents. Leave on-site with permission of site operator and arrange for proper disposal.	N/A
Soil Cuttings	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in a 55-gallon steel drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. **
Groundwater	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. **
Decontamination Water	Containerize in DOT-approved container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. Decontamination water may also be disposed in a sanitary sewer system, with permission from the wastewater treatment plant representative, and if doing so does not endanger human health or the environment, or violate federal or state regulations.
Disposable Equipment	Containerize in DOT-approved container or 5-gallon plastic bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal.	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. If unfeasible, return to FEC for disposal in dumpster.
Trash	N/A	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.

**** These materials may be placed on the ground if doing so does not endanger human health or the environment or violate federal or state regulations.**

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Field Equipment Cleaning and Decontamination**

Effective Date: November 1, 2007	**Number:** SESDPROC-205-R1

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This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-205-R1, *Field Equipment Cleaning and Decontamination*, replaces SESDPROC-205-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.5** Alphabetized and revised the referencing style for consistency. **Section 1.6.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	November 1, 2007
SESDPROC-205-R0, *Field Equipment Cleaning and Decontamination*, Original Issue	February 05, 2007

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Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when cleaning and decontaminating sampling equipment during the course of field investigations.

1.2 Scope/Application

The procedures contained in this document are to be followed when field cleaning sampling equipment, for both re-use in the field, as well as used equipment being returned to the Field Equipment Center (FEC). On the occasion that SESD field investigators determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that other procedures must be used to clean or decontaminate sampling equipment at a particular site, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 Definitions

Decontamination: The process of cleaning dirty sampling equipment to the degree to which it can be re-used, with appropriate QA/QC, in the field.

Field Cleaning: The process of cleaning dirty sampling equipment such that it can be returned to the FEC in a condition that will minimize the risk of transfer of contaminants from a site.

De-ionized water: Tap water that has been treated by passing through a standard de-ionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits)

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as defined by a standard inductively coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan. De-ionized water obtained by other methods is acceptable, as long as it meets the above analytical criteria. Organic-free water may be substituted for de-ionized water.

Organic-free water: Tap water that has been treated with activated carbon and de-ionizing units. At a minimum, the finished water must meet the analytical criteria of de-ionized water and it should contain no detectable pesticides, herbicides, or extractable organic compounds, and no volatile organic compounds above minimum detectable levels as determined by the Region 4 laboratory for a given set of analyses. Organic-free water obtained by other methods is acceptable, as long as it meets the above analytical criteria.

Soap: A standard brand of phosphate-free laboratory detergent, such as Luminox®.

Tap water: Water from any potable water supply. De-ionized water or organic-free water may be substituted for tap water.

Drilling Equipment: All power equipment used to collect surface and sub-surface soil samples or install wells. For purposes of this procedure, direct push is also included in this definition.

1.5 References

SESD Operating Procedure for Management of Investigation Derived Waste, SESDPROC-202, Most Recent Version

SESD Operating Procedure for Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

United States Environmental Protection Agency (US EPA). 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.6 General Precautions

1.6.1 Safety

Proper safety precautions must be observed when field cleaning or decontaminating dirty sampling equipment. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used

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to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate. At a minimum, the following precautions should be taken in the field during these cleaning operations:

- When conducting field cleaning or decontamination using laboratory detergent, safety glasses with splash shields or goggles, and latex gloves will be worn.

- No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted during cleaning operations.

1.6.2 Procedural Precaution

Prior to mobilization to a site, the expected types of contamination should be evaluated to determine if the field cleaning and decontamination activities will generate rinsates and other waste waters that might be considered RCRA hazardous waste or may require special handling.

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2 Introduction to Field Equipment Cleaning and Decontamination

2.1 General

The procedures outlined in this document are intended for use by field investigators for cleaning and decontaminating sampling and other equipment in the field. These procedures should be followed in order that equipment is returned to the FEC in a condition that will minimize the risk of transfer of contaminants from a site.

Sampling and field equipment cleaned in accordance with these procedures must meet the minimum requirements for the Data Quality Objectives (DQOs) of the study or investigation. Site-specific alterations to these procedures should be documented in the study plan. Deviations from these procedures should be documented in the field records.

Cleaning procedures for use at the Field Equipment Center (FEC) are found in SESD Operating Procedure for Equipment Cleaning and Decontamination at the FEC (SESDPROC-206).

2.2 Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- Soap must be kept in clean plastic, metal, or glass containers until used. It should be poured directly from the container during use.

- Tap water may be kept in tanks, hand pressure sprayers, squeeze bottles, or applied directly from a hose.

- De-ionized water must be stored in clean, glass or plastic containers that can be closed prior to use. It can be applied from plastic squeeze bottles.

- Organic-free water must be stored in clean glass or Teflon® containers prior to use. It may be applied using Teflon® squeeze bottles, or with the portable system.

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2.3 Disposal of Cleaning Solutions

Procedures for the safe handling and disposition of investigation derived waste (IDW); including used wash water and rinse water are in SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202).

2.4 Sample Collection Equipment Contaminated with Concentrated Materials

Equipment used to collect samples of concentrated materials from investigation sites must be field cleaned before returning from the study. At a minimum, this should consist of washing with soap and rinsing with tap water. When the above procedure cannot be followed, the following options are acceptable:

1. Leave with facility for proper disposal;

2. If possible, containerize, seal and secure the equipment and leave on-site for later disposal;

3. Containerize, bag or seal the equipment so that no odor is detected and return to the SESD.

It is the project leader's responsibility to evaluate the nature of the sampled material and determine the most appropriate cleaning procedures for the equipment used to sample that material.

2.5 Sample Collection Equipment Contaminated with Environmental Media

Equipment used to collect samples of environmental media from investigation sites should be field cleaned before returning from the study. Based on the condition of the sampling equipment, one or more of the following options must be used for field cleaning:

1. Wipe the equipment clean;

2. Water-rinse the equipment;

3. Wash the equipment in detergent and water followed by a tap water rinse.

4. For grossly contaminated equipment, the procedures set forth in Section 2.4 must be followed.

Under extenuating circumstances such as facility limitations, regulatory limitations, or during residential sampling investigations where field cleaning operations are not feasible, equipment can be containerized, bagged or sealed so that no odor is detected and returned to the FEC without being field cleaned. If possible, FEC personnel should be

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notified that equipment will be returned without being field cleaned. It is the project leader's responsibility to evaluate the nature of the sampled material and determine the most appropriate cleaning procedures for the equipment used to sample that material.

2.6 Handling of Decontaminated Equipment

After decontamination, equipment should be handled only by personnel wearing clean gloves to prevent re-contamination. In addition, the equipment should be moved away (preferably upwind) from the decontamination area to prevent re-contamination. If the equipment is not to be immediately re-used it should be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is kept prior to re-use must be free of contaminants.

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3 Field Equipment Decontamination Procedures

3.1 General

Sufficient equipment should be transported to the field so that an entire study can be conducted without the need for decontamination. When equipment must be decontaminated in the field, the following procedures are to be utilized.

3.2 Specifications for Decontamination Pads

Decontamination pads constructed for field cleaning of sampling and drilling equipment should meet the following minimum specifications:

- The pad should be constructed in an area known or believed to be free of surface contamination.
- The pad should not leak.
- If possible, the pad should be constructed on a level, paved surface and should facilitate the removal of wastewater. This may be accomplished by either constructing the pad with one corner lower than the rest, or by creating a sump or pit in one corner or along one side. Any sump or pit should also be lined.
- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above ground to prevent equipment from being splashed.
- Water should be removed from the decontamination pad frequently.
- A temporary pad should be lined with a water impermeable material with no seams within the pad. This material should be either easily replaced (disposable) or repairable.

At the completion of site activities, the decontamination pad should be deactivated. The pit or sump should be backfilled with the appropriate material designated by the site project leader, but only after all waste/rinse water has been pumped into containers for disposal. See SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202) for proper handling and disposal of these materials. If the decontamination pad has leaked excessively, soil sampling may be required.

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3.3 "Classical Parameter" Sampling Equipment

"Classical Parameters" are analyses such as oxygen demand, nutrients, certain inorganics, sulfide, flow measurements, etc. For routine operations involving classical parameter analyses, water quality sampling equipment such as Kemmerers, buckets, dissolved oxygen dunkers, dredges, etc., may be cleaned with the sample water or tap water between sampling locations as appropriate.

Flow measuring equipment such as weirs, staff gages, velocity meters, and other stream gauging equipment may be cleaned with tap water between measuring locations, if necessary.

Note: The procedures described in Section 3.3 are not to be used for cleaning field equipment to be used for the collection of samples undergoing trace organic or inorganic constituent analyses.

3.4 Sampling Equipment used for the Collection of Trace Organic and Inorganic Compounds

For samples undergoing trace organic or inorganic constituent analyses, the following procedures are to be used for all sampling equipment or components of equipment that come in contact with the sample:

1. Clean with tap water and Luminox® soap using a brush, if necessary, to remove particulate matter and surface films. Equipment may be steam cleaned (Luminox® soap and high pressure hot water) as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.

2. Rinse thoroughly with tap water.

3. Rinse thoroughly with organic-free water and place on a clean foil-wrapped surface to air-dry.

4. All equipment must be wrapped with foil. If the equipment is to be stored overnight before it is wrapped in foil, it should be covered and secured with clean, unused plastic sheeting.

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3.5 Well Sounders or Tapes

The following procedures are recommended for decontaminating well sounders (water level indicators) and tapes:

1. Wash with soap and tap water.

2. Rinse with tap water.

3. Rinse with de-ionized water.

3.6 Redi-Flo2® Pump

The Redi-Flo2® pump should be decontaminated prior to use and between each monitoring well. The following procedure is required:

CAUTION - Make sure the pump is not plugged in.

1. Using a brush, scrub the exterior of the pump, electrical cord and garden hose with soap and tap water. Do not wet the electrical plug.

2. Rinse with tap water.

3. Rinse with de-ionized water.

4. Place the equipment in a clean plastic bag.

To clean the Redi-Flo2® ball check valve:

1. Remove the ball check valve from the pump head. Check for wear and/or corrosion, and replace as needed.

2. Using a brush, scrub all components with soap and tap water.

3. Rinse with de-ionized water.

4. Replace the ball check valve to the Redi-Flo2® pump head.

3.7 Downhole Drilling Equipment

These procedures are to be used for drilling activities involving the collection of soil samples for trace organic and inorganic constituent analyses and for the construction of monitoring wells to be used for the collection of groundwater samples for trace organic and inorganic constituent analyses.

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3.7.1 Introduction

Cleaning and decontamination of all equipment should occur at a designated area (decontamination pad) on the site. The decontamination pad should meet the specifications of Section 3.2 of this procedure.

Tap water brought on the site for drilling and cleaning purposes should be contained in a pre-cleaned tank.

A steam cleaner and/or high pressure hot water washer capable of generating a pressure of at least 2500 PSI and producing hot water and/or steam (200° F plus), with a soap compartment, should be obtained.

3.7.2 Preliminary Cleaning and Inspection

Drilling equipment should be clean of any contaminants that may have been transported from off-site to minimize the potential for cross-contamination. The drilling equipment should not serve as a source of contaminants. Associated drilling and decontamination equipment, well construction materials, and equipment handling procedures should meet these minimum specified criteria:

- All downhole augering, drilling, and sampling equipment should be sandblasted before use if painted, and/or there is a buildup of rust, hard or caked matter, etc., that cannot be removed by steam cleaning (soap and high pressure hot water), or wire brushing. Sandblasting should be performed prior to arrival on site, or well away from the decontamination pad and areas to be sampled.

- Any portion of the drilling equipment that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) and wire brushed (as needed) to remove all rust, soil, and other material which may have come from other sites before being brought on site.

- Printing and/or writing on well casing, tremie tubing, etc., should be removed before use. Emery cloth or sand paper can be used to remove the printing and/or writing. Most well material suppliers can provide materials without the printing and/or writing if specified when ordered. Items that cannot be cleaned are not acceptable and should be discarded.

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- Equipment associated with the drilling and sampling activities should be inspected to insure that all oils, greases, hydraulic fluids, etc., have been removed, and all seals and gaskets are intact with no fluid leaks.

3.7.3 Drill Rig Field Cleaning Procedure

Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) between boreholes.

3.7.4 Field Decontamination Procedure for Drilling Equipment

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment. This procedure does not apply to well casings, well screens, or split-spoon samplers used to obtain samples for chemical analyses, which should be decontaminated as outlined in Section 3.4 of this procedure.

1. Wash with tap water and soap, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning (high pressure hot water with soap) may be necessary to remove matter that is difficult to remove with the brush. Drilling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. Hollow-stem augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids, should be cleaned on the inside with vigorous brushing.

2. Rinse thoroughly with tap water.

3. Remove from the decontamination pad and cover with clean, unused plastic. If stored overnight, the plastic should be secured to ensure that it stays in place.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Packing, Marking, Labeling and Shipping of Environmental and Waste Samples**

Effective Date: April 20, 2011	**Number:** SESDPROC-209-R2

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Document Control Coordinator.

History	Effective Date
SESDPROC-209-R2, *Packing, Marking, Labeling and Shipping of Environmental and Waste Samples*, replaces SESDPROC-209-R1. **Title Page:** Changed EIB Branch Chief from Antonio Quinones to Archie Lee. Changed Field Quality Manager from Laura Ackerman to Liza Montalvo. **Revision History:** Previous versions of the document will be maintained by the Document Control Coordinator (DCC). Changed from Field Quality Manager to DCC. **Section 1.2:** Added the following statement: Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use. **Section 1.3:** Changed requirement so that the DCC is responsible for ensuring the most recent version of the procedure is placed on the SESD LAN and for maintaining records of review conducted prior to its issuance. Deleted reference to the H: drive. **Section 3, fifth paragraph**: On item #2 on the list, replaced "be sure" with "ensure that." On item #3, deleted the last sentence that stated that only "Up to three VOA vials may be packed in one Whirl-Pak container or bag." Deleted outdated item #4 referencing shipment of VOA vials in metal cans. On items #5 and #6, removed references to vermiculite in favor of generic "absorbent material."	April 20, 2011
SESDPROC-209-R1, *Packing, Marking, Labeling and Shipping of Environmental and Waste Samples*, replaces SESDPROC-209-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. Changed Bill Cosgrove's title from Acting Chief to Chief.	November 1, 2007

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Section 1.3 Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Alphabetized and revised the referencing style for consistency. Added reference to the SHEMP Procedures and Policy Manual. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual.	
SESDPROC-209-R0, Packing, Marking, Labeling and Shipping of Environmental and Waste Samples, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by Department of Transportation under 49 CFR, Subchapter C, Hazardous Materials Regulations, and the International Air Transport Authority (IATA), which is equivalent to United Nations International Civil Aviation Organization (UN/ICAO). Transportation of hazardous materials (dangerous goods) by EPA personnel is covered by EPA Order 1000. This document describes general and specific procedures, methods and considerations to be used and observed by SESD field investigators when packing, marking, labeling and shipping environmental and waste samples to ensure that all shipments are in compliance with the above regulations and guidance.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when packing, marking, labeling, and shipping environmental samples and dangerous goods by air transport. Samples collected during field investigations or in response to a hazardous materials incident must be classified prior to shipment, as either environmental or hazardous materials (dangerous goods) samples.

In general, environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, biological specimens, or any samples not expected to be contaminated with high levels of hazardous materials. Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods.

Government employees transporting samples or hazardous materials (i.e., preservatives or waste samples) in government vehicles are not subject to the requirements of this section in accordance with 49 CFR 171.1(d)(5). EPA contractors, however, are not covered by this exemption and may not transport these materials without full compliance with 49 CFR.

Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

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1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the SESD local area network (LAN). The Document Control Coordinator (DCC) is responsible for ensuring the most recent version of the procedure is placed on the LAN and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version.

Title 40 Code of Federal Regulations (CFR), Pt. 136.3, Identification of Test Procedures, July 1, 2001. See Table II, Footnote 3.

Title 49 CFR, Pt. 171.1(d)(5), Applicability of Hazardous Materials Regulations (HMR) to Persons and Functions.

United States Department of Transportation (US DOT). 2003. Letter from Edward T. Mazzullo, Director, Office of Hazardous Materials Standards, to Henry L. Longest II, Acting Assistant Administrator, USEPA, Ref No. 02-0093, February 13, 2003.

US Environmental Protection Agency (US EPA) Order 1000.18, February 16, 1979.

US EPA. 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA.

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version.

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version.

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1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when packing, marking, labeling, and shipping environmental or waste samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASPs) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional.

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2 Shipment of Dangerous Goods

The project leader 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, 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 the waste sample or highly contaminated soil, sediment, or water sample are unknown, or only partially known, the sample may not be offered for air transport.

In addition, the shipment of pre-preserved sample containers or bottles of preservatives (e.g., NaOH pellets, HCL, etc.) which are designated as dangerous goods by IATA is regulated. Shipment of nitric acid is strictly regulated. Consult the IATA Dangerous Goods Regulations for guidance. ***Dangerous goods must not be offered for air transport by any personnel except SESD's dangerous goods shipment designee or other personnel trained and certified by IATA in dangerous goods shipment.***

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3 Shipment of Environmental Samples

Guidance for the shipment of environmental laboratory samples by personnel is provided in a memorandum dated March 6, 1981, subject "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Laboratory Samples". By this memorandum, the shipment of the following unpreserved samples is not regulated:

- Drinking water
- Treated effluent
- Biological specimens
- Sediment
- Water treatment plant sludge
- POTW sludge

In addition, the shipment of the following preserved samples is not regulated, provided the amount of preservative used does not exceed the amounts found in 40 CFR 136.3 or the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version. This provision is also discussed in correspondence between DOT and EPA (Department of Transportation, Letter from Edward T. Mazzullo, Director, Office of Hazardous Materials Standards, to Henry L. Longest II, Acting Assistant Administrator, USEPA, Ref No.: 02-0093, February 13, 2003). It is the shippers' (individual signing the air waybill) responsibility to ensure that proper amounts of preservative are used:

- Drinking water
- Ambient water
- Treated effluent
- Biological specimens
- Sediment
- Wastewater treatment plant sludge
- Water treatment plant sludge

Samples determined by the project leader to be in these categories are to be shipped using the following protocol, developed jointly between USEPA, OSHA, and DOT. This procedure is documented in the "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples."

Untreated wastewater and sludge from Publicly Owned Treatment Works (POTWs) are considered to be "diagnostic specimens" (not environmental laboratory samples). However, because they are not considered to be etiologic agents (infectious) they are not restricted and may be shipped using the procedures outlined below.

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Environmental samples should be packed prior to shipment by air using the following procedures:

1. Allow sufficient headspace (ullage) in all bottles (except VOA containers with a septum seal) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

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

3. Place bottles in separate and appropriately sized polyethylene bags and seal the bags. If available, the use of Whirl-Pak bags is preferable, if unavailable seal regular bags with tape (plastic electrical tape).

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 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 absorbent material.

7. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).

8. Place the Chain-of-Custody Record or the CLP Traffic Report Form (if applicable) into a 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. Chain-of-custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

Title: **Soil Sampling**

Effective Date: November 1, 2007	**Number:** SESDPROC-300-R1

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History	Effective Date
SESDPROC-300-R1, *Soil Sampling*, replaces SESDPROC-300-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch. **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.7** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-300-R0, Soil Sampling, Original Issue	February 05, 2007

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1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting soil samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling soil samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a soil sample, the variant procedure will be documented in the field log book and subsequent investigation report, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field X-Ray Fluorescence (XRF) Measurement, SESDPROC-107, Most Recent Version

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SESD Operating Procedure for Equipment Inventory and Management, SESDPROC-108, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Packaging, Marking, Labeling and Shipping of Environmental and Waste Samples, SESDPROC-209, Most Recent Version

Title 49 Code of Federal Regulations, Pts. 171 to 179, Most Recent Version

United States Environmental Protection Agency (US EPA). 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting soil samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines, however, should only be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting soil samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could

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alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.

- Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader in the project files.

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2 Special Sampling Considerations

2.1 Soil Samples for Volatile Organic Compounds (VOC) Analysis

If samples are to be analyzed for volatile organic compounds, they should be collected in a manner that minimizes disturbance of the sample. For example, when sampling with a bucket auger, the sample for VOC analysis should be collected directly from the auger bucket (preferred) or from minimally disturbed material immediately after an auger bucket is emptied into the pan. The sample shall be containerized by filling an En Core® Sampler or other Method 5035 compatible container. ***Samples for VOC analysis are not homogenized.*** Preservatives may be required for some samples with certain variations of Method 5035. Consult the method or the principal analytical chemist to determine if preservatives are necessary.

2.2 Soil Sampling (Method 5035)

The following sampling protocol is recommended for site investigators assessing the extent of volatile organic compounds (VOC's) in soils at a project site. Because of the large number of options available, careful coordination between field and laboratory personnel is needed. The specific sampling containers and sampling tools required will depend upon the detection levels and intended data use. Once this information has been established, selection of the appropriate sampling procedure and preservation method best applicable to the investigation can be made.

2.2.1 Equipment

Soil for VOC analyses may be retrieved using any of the SESD soil sampling methods described in Sections 3 through 8 of this procedure. Once the soil has been obtained, the En Core® Sampler, syringes, stainless steel spatula, standard 2-oz. soil VOC container, or pre-prepared 40 ml vials may be used/required for sub-sampling. The specific sample containers and the sampling tools required will depend upon the data quality objectives established for the site or sampling investigation. The various sub-sampling methods are described below.

2.2.2 Sampling Methodology - Low Concentrations (<200 ug/kg)

When the total VOC concentration in the soil is expected to be less than 200 µg/kg, the samples may be collected directly with the En Core® Sampler or syringe. If using the syringes, the sample must be placed in the sample container (40 ml pre-prepared vial) immediately to reduce volatilization losses. The 40 ml vials should contain 10 ml of organic-free water for an un-preserved sample or approximately 10 ml of organic-free water and a preservative. It is recommended that the 40 ml vials be prepared and weighed by the laboratory (commercial

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sources are available which supply preserved and tared vials). When sampling directly with the En Core® Sampler, the vial must be immediately capped and locked

A soil sample for VOC analysis may also be collected with conventional sampling equipment. A sample collected in this fashion must either be placed in the final sample container (En Core® Sampler or 40 ml pre-prepared vial) immediately or the sample may be immediately placed into an intermediate sample container with no head space. If an intermediate container (usually 2-oz. soil jar) is used, the sample must be transferred to the final sample container (En Core® Sampler or 40 ml pre-prepared vial) as soon as possible, not to exceed 30 minutes.

NOTE: After collection of the sample into either the En Core® Sampler or other container, the sample must immediately be stored in an ice chest and cooled.

Soil samples may be prepared for shipping and analysis as follows:

En Core® Sampler - the sample shall be capped, locked, and secured in a plastic bag.

Syringe - Add about 3.7 cc (approximately 5 grams) of sample material to 40-ml pre-prepared containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag. Note: When using the syringes, it is important that no air is allowed to become trapped behind the sample prior to extrusion, as this will adversely affect the sample.

Stainless Steel Laboratory Spatulas - Add between 4.5 and 5.5 grams (approximate) of sample material to 40 ml containers. Secure the containers in a plastic bag. Do not use a custody seal on the container; place the custody seal on the plastic bag.

2.2.3 Sampling Methodology - High Concentrations (>200 ug/kg)

Based upon the data quality objectives and the detection level requirements, this high level method may also be used. Specifically, the sample may be packed into a single 2-oz. glass container with a screw cap and septum seal. The sample container must be filled quickly and completely to eliminate head space. Soils\sediments containing high total VOC concentrations may also be collected as described in Section 2.2.2, Sampling Methodology - Low Concentrations, and preserved using 10 ml methanol.

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2.2.4 Special Techniques and Considerations for Method 5035

Effervescence

If low concentration samples effervesce from contact with the acid preservative, then either a test for effervescence must be performed prior to sampling, or the investigators must be prepared to collect each sample both preserved or un-preserved as needed, or all samples must be collected unpreserved.

To check for effervescence, collect a test sample and add to a pre-preserved vial. If preservation (acidification) of the sample results in effervescence (rapid formation of bubbles) then preservation by acidification is not acceptable, and the sample must be collected un-preserved.

If effervescence occurs and only pre-preserved sample vials are available, the preservative solution may be placed into an appropriate hazardous waste container and the vials triple rinsed with organic free water. An appropriate amount of organic free water, equal to the amount of preservative solution, should be placed into the vial. The sample may then be collected as an un-preserved sample. Note that the amount of organic free water placed into the vials will have to be accurately measured.

Sample Size

While this method is an improvement over earlier ones, field investigators must be aware of an inherent limitation. Because of the extremely small sample size and the lack of sample mixing, sample representativeness for VOC's may be reduced compared to samples with larger volumes collected for other constituents. The sampling design and objectives of the investigation should take this into consideration.

Holding Times

Sample holding times are specified in the Analytical Support Branch *Laboratory Operations and Quality Assurance Manual* (ASBLOQAM), Most Recent Version. Field investigators should note that the holding time for an un-preserved VOC soil/sediment sample is 48 hours. Arrangements should be made to ship the soil/sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and/or analyze the sample within 48 hours of collection.

Percent Moisture

Samplers must ensure that the laboratory has sufficient material to determine percent moisture in the VOC soil/sediment sample to correct the analytical results to dry weight. If other analyses requiring percent moisture determination are

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being performed upon the sample, these results may be used. If not, a separate sample (minimum of 2 oz.) for percent moisture determination will be required. The sample collected for Percent Moisture may also be used by the laboratory to check for preservative compatibility.

Safety

Methanol is a toxic and flammable liquid. Therefore, methanol must be handled with all required safety precautions related to toxic and flammable liquids. Inhalation of methanol vapors must be avoided. Vials should be opened and closed quickly during the sample preservation procedure. Methanol must be handled in a ventilated area. Use protective gloves when handling the methanol vials. Store methanol away from sources of ignition such as extreme heat or open flames. The vials of methanol should be stored in a cooler with ice at all times.

Shipping

Methanol and sodium bisulfate are considered dangerous goods, therefore shipment of samples preserved with these materials by common carrier is regulated by the U.S. Department of Transportation and the International Air Transport Association (IATA). The rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179) and the current edition of the IATA Dangerous Goods Regulations must be followed when shipping methanol and sodium bisulfate. Consult the above documents or the carrier for additional information. Shipment of the quantities of methanol and sodium bisulfate used for sample preservation falls under the exemption for small quantities.

The summary table on the following page lists the options available for compliance with SW846 Method 5035. The advantages and disadvantages are noted for each option. SESD's goal is to minimize the use of hazardous material (methanol and sodium bisulfate) and minimize the generation of hazardous waste during sample collection.

2.3 Dressing Soil Surfaces

Any time a vertical or near vertical surface is sampled, such as achieved when shovels or similar devices are used for subsurface sampling, the surface should be dressed (scraped) to remove smeared soil. This is necessary to minimize the effects of contaminant migration interferences due to smearing of material from other levels.

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Table 1: Method 5035 Summary

OPTION	PROCEDURE	ADVANTAGES	DISADVANTAGES
1	Collect 2 - 40 mL vials with ~5 grams of sample and 1 - 2 oz., glass w/septum lid for screening, % moisture and preservative compatibility	Screening conducted by lab	Presently a 48 hour holding time for unpreserved samples Sample containers must be tared
2	Collect 3 En Core® Samplers; and 1- 2 oz., glass w/septum lid for screening, % moisture and preservative compatibility	Lab conducts all preservation/preparation procedures	Presently a 48 hour holding time for preparation of samples
3	Collect 2 - 40 ml vials with 5 grams of sample and preserve w/methanol or sodium bisulfate and 1 - 2-oz., glass w/septum lid for screening, % moisture and preservative compatibility	High level VOC samples may be composited Longer holding time	Hazardous materials used in field Sample containers must be tared
4	Collect 1 - 2-oz., glass w/septum lid for analysis, % moisture and preservative compatibility	Lab conducts all preservation/preparation procedures	May have significant VOC loss

2.4 Special Precautions for Trace Contaminant Soil Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different sample is collected and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be collected, handled and stored separately.
- All background samples shall be segregated from obvious high concentration or waste samples. Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.

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- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Samplers must use new, verified certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205), for collection of samples for trace metals or organic compound analyses.

2.5 Sample Homogenization

1. If sub-sampling of the primary sample is to be performed in the laboratory, transfer the entire primary sample directly into an appropriate, labeled sample container(s). Proceed to step 5.

2. If sub-sampling the primary sample in the field or compositing multiple primary samples in the field, place the sample into a glass or stainless steel homogenization container and mix thoroughly. Each aliquot of a composite sample should be of the same approximate volume.

3. All soil samples must be thoroughly mixed to ensure that the sample is as representative as possible of the sample media. ***Samples for VOC analysis are not homogenized.*** The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

   - The material in the sample pan should be divided into quarters and each quarter should be mixed individually.
   - Two quarters should then be mixed to form halves.
   - The two halves should be mixed to form a homogenous matrix.

   This procedure should be repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over.

4. Place the sample into an appropriate, labeled container(s) by using the alternate shoveling method and secure the cap(s) tightly. The alternate shoveling method involves placing a spoonful of soil in each container in sequence and repeating until the containers are full or the sample volume has been exhausted. Threads on the container and lid should be cleaned to ensure a tight seal when closed.

5. Return any unused sample material back to the auger, drill or push hole from which the sample was collected.

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2.6 Quality Control

If possible, a control sample should be collected from an area not affected by the possible contaminants of concern and submitted with the other samples. This control sample should be collected as close to the sampled area as possible and from the same soil type. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by sampling tools. SESD Operating Procedure for Field Sampling Quality Control (SESDPROC-011) contains other procedures that may be applicable to soil sampling investigations.

2.7 Records

Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation, as described in the SESD Operating Procedure for Logbooks (SESDPROC-010) and the SESD Operating Procedure for Sample and Evidence Management (SESDPROC-005).

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3 Manual Soil Sampling Methods

3.1 General

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface. The most common interval is 0 to 6 inches, however the data quality objectives of the investigation may dictate another interval, such as 0 to 3 inches for risk assessment purposes. The shallow subsurface interval may be considered to extend from approximately 12-inches below ground surface to a site-specific depth at which sample collection using manual collection methods becomes impractical.

3.2 Spoons

Stainless steel spoons may be used for surface soil sampling to depths of approximately 6-inches below ground surface where conditions are generally soft and non-indurated and there is no problematic vegetative layer to penetrate.

3.2.1 Special Considerations When Using Spoons

- When using stainless steel spoons, consideration must be given to the procedure used to collect the volatile organic compound sample. If the soil being sampled is cohesive and holds its in situ texture in the spoon, the En Core® Sampler or syringe used to collect the sub-sample for Method 5035 should be plugged directly from the spoon. If, however, the soil is not cohesive and crumbles when removed from the ground surface for sampling, consideration should be given to plugging the sample for Method 5035 directly from the ground surface at a depth appropriate for the investigation Data Quality Objectives.
- When compositing, make sure that each composite location (aliquot) consist of equal volumes, i.e., same number of equal spoonfuls.
- If a thick, matted root zone is present at or near the surface, it should be removed before the sample is collected

3.3 Hand Augers

Hand augers may be used to advance boreholes and collect soil samples in the surface and shallow subsurface intervals. Typically, 4-inch stainless steel auger buckets with cutting heads are used. The bucket is advanced by simultaneously pushing and turning using an attached handle.

3.3.1 Surface Soil Sampling

When conducting surface soil sampling with hand augers, the auger buckets may be used with a handle alone or with a handle and extensions. The bucket is

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advanced to the appropriate depth and the contents are transferred to the homogenization container for processing. Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

3.3.2 Subsurface Soil Sampling

Hand augers are the most common equipment used to collect shallow subsurface soil samples. Auger holes are advanced one bucket at a time until the sample depth is achieved. When the sample depth is reached, the bucket used to advance the hole is removed and a clean bucket is attached. The clean auger bucket is then placed in the hole and filled with soil to make up the sample and removed.

The practical depth of investigation using a hand auger depends upon the soil properties and depth of investigation. In sand, augering is usually easily performed, but the depth of collection is limited to the depth at which the sand begins to flow or collapse. Hand augers may also be of limited use in tight clays or cemented sands. In these soil types, the greater the depth attempted, the more difficult it is to recover a sample due to increased friction and torqueing of the hand auger extensions. At some point these problems become so severe that power equipment must be used.

3.3.3 Special Considerations for Soil Sampling with the Hand Auger

- Because of the tendency for the auger bucket to scrape material from the sides of the auger hole while being extracted, the top several inches of soil in the auger bucket should be discarded prior to placing the bucket contents in the homogenization container for processing.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035. Collect the VOC sample directly from the auger bucket, if possible.
- Power augers, such as the Little Beaver®, and drill rigs may be used to advance boreholes to depths for subsurface soil sampling with the hand auger. They may not be used for sample collection. When power augers are used to advance a borehole to depth for sampling, care must be taken that exhaust fumes, gasoline and/or oil do not contaminate the borehole or area in the immediate vicinity of sampling.
- When a new borehole is advanced, the entire hand auger assembly must be replaced with a properly decontaminated hand auger assembly.

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4 Direct Push Soil Sampling Methods

4.1 General

These methods are used primarily to collect shallow and deep subsurface soil samples. Three methods are available for use with either the Geoprobe® or the drill rig adapted with a hydraulic hammer. All methods involve the collection and retrieval of the soil sample within a thin-walled liner. The following sections describe each of the specific sampling methods that can be accomplished using direct push techniques, along with details specific to each method.

4.2 Large Bore® Soil Sampler

The Large Bore® (LB) sampler is a solid barrel direct push sampler equipped with a piston-rod point assembly used primarily for collection of depth-discrete subsurface soil samples. The sample barrel is approximately 30-inches (762 mm) long and has a 1.5-inch (38 mm) outside diameter. The LB® sampler is capable of recovering a discrete sample core 22 inches x 1.0 inch (559 mm x 25 mm) contained inside a removable liner. The resultant sample volume is a maximum of 283 ml.

After the LB® sample barrel is equipped with the cutting shoe and liner, the piston-rod point assembly is inserted, along with the drive head and piston stop assembly. The assembled sampler is driven to the desired sampling depth, at which time the piston stop pin is removed, freeing the push point. The LB® sampler is then pushed into the soil a distance equal to the length of the LB® sample barrel. The probe rod string, with the LB® sampler attached, is then removed from the subsurface. After retrieval, the LB® sampler is then removed from the probe rod string. The drive head is then removed to allow removal of the liner and soil sample.

4.3 Macro-Core® Soil Sampler

The Macro-Core® (MC) sampler is a solid barrel direct push sampler equipped with a piston-rod point assembly used primarily for collection of either continuous or depth-discrete subsurface soil samples. Although other lengths are available, the standard MC® sampler has an assembled length of approximately 52 inches (1321 mm) with an outside diameter of 2.2 inches (56 mm). The MC® sampler is capable of recovering a discrete sample core 45 inches x 1.5 inches (1143 mm x 38 mm) contained inside a removable liner. The resultant sample volume is a maximum of 1300 ml. The MC® sampler may be used in either an open-tube or closed-point configuration. Samples collected for chemical analyses must be collected with the closed-point configuration. If used for collection of soil for stratigraphic descriptions, the open-tubed configuration is acceptable.

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4.4 Dual Tube Soil Sampling System

The Dual Tube 21 soil sampling system is a direct push system for collecting continuous core samples of unconsolidated materials from within a sealed outer casing of 2.125-inch (54 mm) OD probe rod. The samples are collected within a liner that is threaded onto the leading end of a string of 1.0-inch diameter probe rod. Collected samples have a volume of up to 800 ml in the form of a 1.125-inch x 48-inch (29 mm x 1219 mm) core. Use of this method allows for collection of continuous core inside a cased hole, minimizing or preventing cross-contamination between different intervals during sample collection. The outer casing is advanced, one core length at a time, with only the inner probe rod and core being removed and replaced between samples. If the sampling zone of interest begins at some depth below ground surface, a solid drive tip must be used to drive the dual tube assembly and core to its initial sample depth.

4.5 Special Considerations When Using Direct Push Sampling Methods

- *Liner Use and Material Selection* – Due to the mode of operation, the samples must be collected with a liner. Liners are available in the following materials: stainless steel, brass, cellulose acetate butyrate (CAB), PETG, polyvinyl chloride (PVC) and Teflon®. For the majority of environmental investigations conducted by EIB, either CAB or Teflon® liners are used. If samples are collected for organic compound analyses, Teflon® liners are required. CAB or PVC liners may be used if metals or other inorganic constituents are the object of the investigation.
- *Sample Orientation* – When the liners and associated sample are removed from the sample tubes, it is important to maintain the proper orientation of the sample. This is particularly important when multiple sample depths are collected from the same push. It is also important to maintain proper orientation to define precisely the depth at which an aliquot was collected. Maintaining proper orientation is typically accomplished using vinyl end caps. Convention is to place red caps on the top of the liner and black caps on the bottom to maintain proper sample orientation. Orientation can also be indicated by marking on the exterior of the liner with a permanent marker.
- *Core Catchers* – Occasionally the material being sampled lacks cohesiveness and is subject to crumbling and falling out of the sample liner. In cases such as these, the use of core catchers on the leading end of the sampler may help retain the sample until it is retrieved to the surface. Materials of construction for core catchers must be consistent with the type of liner used, i.e., if stainless steel liners are required, stainless steel core catchers must be used.
- *VOC Sample Collection* - Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

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5 Split Spoon/Drill Rig Methods

5.1 General

Split spoon sampling methods are used primarily to collect shallow and deep subsurface soil samples. All split spoon samplers, regardless of size, are basically split cylindrical barrels that are threaded on each end. The leading end is held together with a beveled threaded collar that functions as a cutting shoe. The other end is held together with a threaded collar that serves as the sub used to attach the spoon to the string of drill rod. Two basic methods are available for use, including the smaller diameter standard split spoon, driven with the drill rig safety hammer, and the larger diameter continuous split spoon, advanced inside and slightly ahead of the lead auger during hollow stem auger drilling. The following sections describe each of the specific sampling methods, along with details specific to each method.

5.2 Standard Split Spoon

A drill rig is used to advance a borehole to the target depth. The drill string is then removed and a standard split spoon is attached to a string of drill rod. Split spoons used for soil sampling must be constructed of stainless steel and are typically 2.0-inches OD (1.5-inches ID) and 18-inches to 24-inches in length. Other diameters and lengths are common and may be used if constructed of the proper material. After the spoon is attached to the string of drill rod it is lowered into the borehole. The drill rig safety hammer is then used to drive the split spoon into the soil at the bottom of the borehole. After the split spoon has been driven into the soil, filling the spoon, it is retrieved to the surface, where it is removed from the drill rod string and opened for sample acquisition.

5.3 Continuous Split Spoon

The continuous split spoon is a large diameter split spoon that is advanced into the soil column inside a hollow stem auger. Continuous split spoons are typically 3-inches to 5-inches in diameter and either 5-feet or 10-feet in length, although the 5-foot long samplers are most common. After the auger string has been advanced into the soil column a distance equal to the length of the sampler being used it is returned to the surface. The sampler is removed from inside the hollow stem auger and the threaded collars are removed. The split spoon is then opened for sampling.

5.4 Special Considerations When Using Split Spoon Sampling Methods

- Always discard the top several inches of material in the spoon before removing any portion for sampling. This material normally consists of borehole wall material that has sloughed off of the borehole wall after removal of the drill string prior to and during inserting the split spoon.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

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6 Shelby Tube/Thin-Walled Sampling Methods

6.1 General

Shelby tubes, also referred to generically as thin-walled push tubes or Acker thin-walled samplers, are used to collect subsurface soil samples in cohesive soils and clays during drilling activities. In addition to samples for chemical analyses, Shelby tubes are also used to collect relatively undisturbed soil samples for geotechnical analyses, such as hydraulic conductivity and permeability, to support hydrogeologic characterizations at hazardous waste and other sites.

6.2 Shelby Tube Sampling Method

A typical Shelby tube is 30-inches in length and has a 3.0-inch OD (2.875 ID) and may be constructed of steel, stainless steel, galvanized steel, or brass. They also typically are attached to push heads that are constructed with a ball-check to aid in holding the contained sample during retrieval. If used for collecting samples for chemical analyses, it must be constructed of stainless steel. If used for collecting samples for standard geotechnical parameters, any material is acceptable.

To collect a sample, the tube is attached to a string of drill rod and is lowered into the borehole, where the sampler is then pressed into the undisturbed clay or silts by hydraulic force. After retrieval to the surface, the tube containing the sample is then removed from the sampler head. If samples for chemical analyses are needed, the soil contained inside the tube is then removed for sample acquisition. If the sample is collected for geotechnical parameters, the tube is typically capped, maintaining the sample in its relatively undisturbed state, and shipped to the appropriate geotechnical laboratory.

6.3 Special Considerations When Using Split Spoon Sampling Methods

Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

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7 Backhoe Sampling Method

7.1 General

Backhoes may be used in the collection of surface and shallow subsurface soil samples. The trenches created by excavation with a backhoe offer the capability of collecting samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. If possible, the sample should be collected without entering the trench. Samples may be obtained from the trench wall or they may be obtained directly from the bucket at the surface. The following sections describe various techniques for safely collecting representative soil samples with the aid of a backhoe.

7.2 Scoop and Bracket Method

If a sample interval is targeted from the surface, it can be sampled using a stainless steel scoop and bracket. First a scoop and bracket are affixed to a length of conduit and is lowered into the backhoe pit. The first step is to take the scoop and scrape away the soil comprising the surface of the excavated wall. This material likely represents soil that has been smeared by the backhoe bucket from adjacent material. After the smeared material has been scraped off, the original stainless steel scoop is removed and a clean stainless steel scoop is placed on the bracket. The clean scoop can then be used to remove sufficient volume of soil from the excavation wall to make up the required sample volume.

7.3 Direct-From-Bucket Method

It is also possible to collect soil samples directly from the backhoe bucket at the surface. Some precision with respect to actual depth or location may be lost with this method but if the soil to be sampled is uniquely distinguishable from the adjacent or nearby soils, it may be possible to characterize the material as to location and depth. In order to ensure representativeness, it is also advisable to dress the surface to be sampled by scraping off any smeared material that may cross-contaminate the sample.

7.4 Special Considerations When Sampling with a Backhoe

- Do not physically enter backhoe excavations to collect a sample. Use either procedure 7.2, Scoop and Bracket Method, or procedure 7.3, Direct-From-Bucket Method to obtain soil for sampling.
- Smearing is an important issue when sampling with a backhoe. Measures must be taken, such as dressing the surfaces to be sampled (see Section 2.3), to mitigate problems with smearing.

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- Paint, grease and rust must be removed and the bucket decontaminated prior to sample collection.
- Observe precautions for volatile organic compound sample collection found in Section 2.2.4, Special Techniques and Considerations for Method 5035.

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Region 4
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
Athens, Georgia

OPERATING PROCEDURE

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Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by the SESD Field Quality Manager.

History	Effective Date
SESDPROC-301-R1, *Groundwater Sampling*, replaces SESDPROC-301-R0. **General** Corrected any typographical, grammatical and/or editorial errors. **Title Page** Changed title for Antonio Quinones from Environmental Investigations Branch to Enforcement and Investigations Branch **Section 1.3** Updated information to reflect that the procedure is located on the H: drive of the LAN. Clarified Field Quality Manager (FQM) responsibilities. **Section 1.4** Updated referenced operating procedures due to changes in title names. Alphabetized and revised the referencing style for consistency. **Section 1.5.1** Corrected the title of the Safety, Health, and Environmental Management Program Procedures and Policy Manual. **Section 1.5.2, 4th bullet** Added references to the CFR and IATA's Dangerous Goods Regulations. **Section 2.5** Updated referenced operating procedures due to changes in title names.	November 1, 2007
SESDPROC-301-R0, Groundwater Sampling, Original Issue	February 05, 2007

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Contents

1 General Information

1.1 Purpose

This document describes general and specific procedures, methods and considerations to be used and observed when collecting groundwater samples for field screening or laboratory analysis.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting and handling groundwater samples in the field. On the occasion that SESD field personnel determine that any of the procedures described in this section are either inappropriate, inadequate or impractical and that another procedure must be used to obtain a groundwater sample, the variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use.

1.3 Documentation/Verification

This procedure was prepared by persons deemed technically competent by SESD management, based on their knowledge, skills and abilities and have been tested in practice and reviewed in print by a subject matter expert. The official copy of this procedure resides on the H: drive of the SESD local area network. The Field Quality Manager (FQM) is responsible for ensuring the most recent version of the procedure is placed on the H: drive and for maintaining records of review conducted prior to its issuance.

1.4 References

International Air Transport Authority (IATA). Dangerous Goods Regulations, Most Recent Version

Puls, Robert W., and Michael J. Barcelona. 1989. Filtration of Ground Water Samples for Metals Analysis. Hazardous Waste and Hazardous Materials 6(4), pp.385-393.

Puls, Robert W., Don A. Clark, and Bert Bledsoe. 1992. Metals in Ground Water: Sampling Artifacts and Reproducibility. Hazardous Waste and Hazardous Materials 9(2), pp. 149-162.

SESD Guidance Document, Design and Installation of Monitoring Wells, SESDGUID-001, Most Recent Version

SESD Operating Procedure for Control of Records, SESDPROC-002, Most Recent Version

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SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005, Most Recent Version

SESD Operating Procedure for Logbooks, SESDPROC-010, Most Recent Version

SESD Operating Procedure for Field Sampling Quality Control, SESDPROC-011, Most Recent Version

SESD Operating Procedure for Field pH Measurement, SESDPROC-100, Most Recent Version

SESD Operating Procedure for Field Specific Conductance Measurement, SESDPROC-101, Most Recent Version

SESD Operating Procedure for Field Temperature Measurement, SESDPROC-102, Most Recent Version

SESD Operating Procedure for Field Turbidity Measurement, SESDPROC-103, Most Recent Version

SESD Operating Procedure for Groundwater Level and Well Depth Measurement, SESDPROC-105, Most Recent Version

SESD Operating Procedure for Management of Investigation Derived Waste, SESDROC-202, Most Recent Version

SESD Operating Procedure for Pump Operation, SESDPROC-203, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination, SESDPROC-205, Most Recent Version

SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC, SESDPROC-206, Most Recent Version

SESD Operating Procedure for Potable Water Supply Sampling, SESDPROC-305, Most Recent Version

United States Environmental Protection Agency (US EPA). 1975. Handbook for Evaluating Water Bacteriological Laboratories. Office of Research and Development (ORD), Municipal Environmental Research Laboratory, Cincinnati, Ohio.

US EPA. 1977. Sampling for Organic Chemicals and Microorganisms in the Subsurface. EPA-600/2-77/176.

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US EPA. 1978. Microbiological Methods for Monitoring the Environment, Water and Wastes. ORD, Municipal Environmental Research Laboratory, Cincinnati, Ohio.

US EPA. 1981. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

US EPA. 1995. Ground Water Sampling - A Workshop Summary. Proceedings from the Dallas, Texas November 30 – December 2, 1993 Workshop. ORD, Robert S. Kerr Environmental Research Laboratory. EPA/600/R-94/205, January 1995.

US EPA. 2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. Region 4 Science and Ecosystem Support Division (SESD), Athens, GA

US EPA. Analytical Support Branch Laboratory Operations and Quality Assurance Manual. Region 4 SESD, Athens, GA, Most Recent Version

US EPA. Safety, Health and Environmental Management Program Procedures and Policy Manual. Region 4 SESD, Athens, GA, Most Recent Version

1.5 General Precautions

1.5.1 Safety

Proper safety precautions must be observed when collecting groundwater samples. Refer to the SESD Safety, Health and Environmental Management Program (SHEMP) Procedures and Policy Manual and any pertinent site-specific Health and Safety Plans (HASP) for guidelines on safety precautions. These guidelines should be used to complement the judgment of an experienced professional. Address chemicals that pose specific toxicity or safety concerns and follow any other relevant requirements, as appropriate.

1.5.2 Procedural Precautions

The following precautions should be considered when collecting groundwater samples.

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment.
- Always sample from the anticipated cleanest, i.e., least contaminated location, to the most contaminated location. This minimizes the opportunity for cross-contamination to occur during sampling.

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- Collected samples must remain in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.
- Shipped samples shall conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Documentation of field sampling is done in a bound logbook.
- Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., shall be retained by the project leader and placed in the project files.

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2 Special Sampling Considerations

2.1 Volatile Organic Compounds (VOC) Analysis

Groundwater samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vial may be either preserved with concentrated hydrochloric acid or they may be unpreserved. Preserved samples have a two week holding time, whereas unpreserved samples have only a seven day holding time. In the great majority of cases, the preserved vials are used to take advantage of the extended holding time. In some situations, however, it may be necessary to use the unpreserved vials. For example, if the groundwater has a high amount of dissolved limestone, i.e., is highly calcareous, there will most likely be an effervescent reaction between the hydrochloric acid and the water, producing large numbers of fine bubbles. This will render the sample unacceptable. In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

The samples should be collected with as little agitation or disturbance as possible. The vial should be filled so that there is a meniscus at the top of the vial and absolutely no bubbles or headspace should be present in the vial after it is capped. After the cap is securely tightened, the vial should be inverted and tapped on the palm of one hand to see if any undetected bubbles are dislodged. If a bubble or bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to flush any preservative out of the vial during topping off. If, after topping off and capping the vial, bubbles are still present, a new vial should be obtained and the sample re-collected.

Samples for VOC analysis must be collected using either stainless steel or Teflon® equipment, such as:

- Bailers must be constructed of stainless steel or Teflon®
- RediFlo2® submersible pumps used for sampling should be equipped with Teflon® sample delivery tubing
- Peristaltic pump/vacuum jug assemblies should be outfitted with Teflon® tubing from the water column to the transfer cap, which should also be constructed of Teflon®

2.2 Special Precautions for Trace Contaminant Groundwater Sampling

- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact

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with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.

- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
- Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.
- If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.
- Clean plastic sheeting will be placed on the ground at each sample location to prevent or minimize contaminating sampling equipment by accidental contact with the ground surface.
- Samplers must use new, verified certified-clean disposable or non-disposable equipment cleaned according to procedures contained in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) for collection of samples for trace metals or organic compound analyses.

2.3 Sample Handling and Preservation Requirements

1. Groundwater samples will typically be collected from the discharge line of a pump or from a bailer, either from the pour stream of an up-turned bailer or from the stream from a bottom-emptying device. Efforts should be made to reduce the flow from either the pump discharge line or the bailer during sample collection to minimize sample agitation.

2. During sample collection, make sure that the pump discharge line or the bailer does not contact the sample container.

3. Place the sample into appropriate, labeled containers. Samples collected for VOC analysis must not have any headspace (see Section 2.1, Volatile Organic Compound Analysis). All other sample containers must be filled with an allowance for ullage.

4. All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection. If preserved VOC vials are used, these will be preserved with concentrated hydrochloric acid by ASB personnel prior to departure for the field investigation. All other chemical preservatives required for the remaining suite of analytes will be supplied by ASB personnel and will be added to the samples by SESD field personnel or other

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authorized persons. The adequacy of sample preservation will be checked after the addition of the preservative for all samples except for the samples collected for VOC analysis. Additional preservative should be added to achieve adequate preservation. Preservation requirements for groundwater samples are found in the USEPA Region 4 Analytical Support Branch Laboratory Operations and Quality Assurance Manual (ASBLOQAM), Most Recent Version.

2.4 Quality Control

If possible, a control sample should be collected from location not affected by the possible contaminants of concern and submitted with the other samples. This control sample should be collected as close to the sampled area as possible and from the same water-bearing formation. Equipment blanks should be collected if equipment is field cleaned and re-used on-site or if necessary to document that low-level contaminants were not introduced by pumps, bailers or other sampling equipment.

2.5 Records

Information generated or obtained by SESD personnel will be organized and accounted for in accordance with SESD records management procedures found in SESD Operating Procedure for Control of Records, SESDPROC-002. Field notes, recorded in a bound field logbook, will be generated, as well as chain-of-custody documentation in accordance with SESD Operating Procedure for Logbooks, SESDPROC-010 and SESD Procedure for Sample and Evidence Management, SESDPROC-005.

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3 Groundwater Sampling Methods - Purging

3.1 General

3.1.1 Purging and Purge Adequacy

Purging is the process of removing stagnant water from a well, immediately prior to sampling, causing its replacement by ground water from the adjacent formation that is representative of actual aquifer conditions. In order to determine when a well has been adequately purged, field investigators should monitor the pH, specific conductance, temperature, and turbidity of the ground water removed during purging and, in the case of permanent monitoring wells, observe and record the volume of water removed.

Prior to initiating the purge, the amount of water standing in the water column (water inside the well riser and screen) should be determined, if possible. To do this, the diameter of the well should be determined and the water level and total depth of the well should be measured and recorded. Specific methodology for obtaining these measurements is found in SESD Operating Procedure for Groundwater Level and Well Depth Measurement (SESDPROC-105). Once this information is obtained, the volume of water to be purged can be determined using one of several methods. One is the equation:

$$V = 0.041\ d^2 h$$

Where: h = depth of water in feet
d = diameter of well in inches
V = volume of water in gallons

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in Table 3.1.1. The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in the Table 3.1.1 which corresponds to the appropriate well diameter, providing the amount of water, in gallons, contained in the well, i.e., one well or water column volume. Other acceptable methods include the use of nomographs or other equations or formulae.

With respect to volume, an adequate purge is normally achieved when three to five well volumes have been removed. The field notes should reflect the single well volume calculations or determinations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal.

With respect to the ground water chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the ground water have stabilized

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TABLE 3.1.1
WELL CASING DIAMETER vs. VOLUME

WELL CASING DIAMETER (INCHES) vs. VOLUME (GALS.)/FEET of WATER	
CASING	GALLONS/FT
1	0.041
2	0.163
3	0.367
4	0.653
5	1.02
6	1.469
7	1.999
8	2.611
9	3.305
10	4.08
11	4.934
12	5.875

and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs) (twice the Primary Drinking Water Standard of 5 NTUs). Although 10 NTUs is normally considered the minimum goal for most ground water sampling objectives, lower turbidity has been shown to be easily achievable in most situations and reasonable attempts should be made to achieve these lower levels. Stabilization occurs when, for at least three consecutive measurements, the pH remains constant within 0.1 Standard Unit (SU), specific conductance varies no more than approximately 10 percent, and the temperature is constant. There are no set criteria for establishing how many total sets of measurements are adequate to document stability of parameters. If the calculated purge volume is small, the measurements should be taken frequently enough to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes, for example, may be sufficient. See the SESD Operating Procedure for Field pH Measurement (SESDPROC-100), SESD Operating Procedure for Field Specific Conductance Measurement (SESDPROC-101), SESD Operating Procedure for Field Temperature Measurement (SESDPROC-102) and SESD Operating Procedure for Field Turbidity Measurement (SESDPROC-103) for procedures for conducting these purge adequacy measurements.

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If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes (up to five well volumes), should be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. If, after five well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible, with respect to turbidity. The conditions of sampling should be noted in the field log.

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, this generally constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). ***It is not necessary that the well be evacuated three times before it is sampled***. The pH, specific conductance, temperature, and turbidity should be measured and recorded, during collection of the sample from the recovered volume, as the measurements of record for the sampling event.

For wells with slow recovery, attempts should be made to avoid purging them to dryness. This can be accomplished, for example, by slowing the purge rate. If a well is purged to dryness, it may result in the sample being comprised partially of water contained in the sand pack, which may be reflective, at least in part, of initial, stagnant conditions. Additionally, as water enters a well that has been purged to dryness, it may cascade down the sand pack and/or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column.

It is particularly important that wells be sampled as soon as possible after purging. If adequate volume is available immediately upon completion of purging, the well must be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered. Sampling of wells which have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered. Wells of this type should not be purged at the end of one day and sampled the following day.

3.1.2 Equipment Considerations for Purging

Monitoring well purging is preferably accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. The equipment utilized by Branch personnel will usually consist of peristaltic pumps and variable speed electric submersible pumps, but may also include bladder pumps or inertial pumps. The pump of choice is usually a function of the well diameter, the depth to water, the depth of the well and the amount of water that is to be removed during purging. Whenever the head difference between the sampling location and the water level is less than the limit of suction and the volume to be removed is reasonably small, a peristaltic pump

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should be used for purging. For wells where the water level is below the limit of suction and/or there is a large volume of water to be purged, the variable speed electric submersible pump would be the pump of choice. SESD Operating Procedure for Pump Operation (SESDPROC-203) contains the use and operating instructions for all pumps commonly used during SESD ground water investigations.

Bailers may also be used for purging in appropriate situations, however, their use is discouraged. Bailers tend to disturb any sediment that may be present in the well, creating or increasing sample turbidity. If a bailer is used, it should be a closed-top Teflon® bailer.

3.2 Wells Without Plumbing or In-Place Pumps

For permanent monitoring wells, the depth to water (water level) and depth of the well (total depth) should be determined before purging. Caution should be exercised during this procedure to prevent cross-contamination between wells. This is a critical concern when samples for trace organic compounds or metals analyses are collected. See SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205**)** for cleaning procedures for well sounders. After cleaning, the well sounding device should be protected to keep it clean until its next use.

3.2.1 Purging with Pumps

3.2.1.1 Peristaltic Pumps

The following step-by-step procedures describe the process of purging with a peristaltic pump:

1. Cut a length of standard-cleaned (SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) Teflon® tubing, equal to the well depth plus an additional five to ten feet. Enough tubing is needed to run from the ground surface up to the top of the well casing and back down to the bottom of the well. This will allow for operation of the pump at all possible water level conditions in the well.

2. Place one end of the tubing into the vacuum side of the peristaltic pump head. Proper sizing of the Teflon® and Silastic® or Tygon® tubing should allow for a snug fit of the Teflon® tubing inside the flexible tubing mounted in the pump head.

3. Run a short section of tubing (does not have to be Teflon®) from the discharge side of the pump head to a graduated bucket.

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4. Place the free end of the Teflon® tubing into the well until the end of the tubing is just below the surface of the water column.

5. Secure the Teflon® tubing to the well casing or other secure object using electrician's tape or other suitable means. This will prevent the tubing from being lost in the well should the tubing detach from the pump head.

6. Turn on the pump to produce a vacuum on the well side of the pump head and begin the purge. Observe pump direction to ensure that a vacuum is being applied to the purge line. If the purge line is being pressurized, either switch the tubing at the pump head or reverse the polarity of the cables on the pump or on the battery.

7. If the pumping rate exceeds the recovery rate of the well, continue to lower the tubing into the well, as needed, until the drawdown stabilizes or the well is evacuated to dryness. If the pump is a variable speed peristaltic pump, and the water level in the well is being drawn down, reduce the speed of the pump in an attempt to stabilize the drawdown. If the well can be purged without evacuating the well to dryness, a sample with greater integrity can be obtained.

8. For wells which are not evacuated to dryness, particularly those with recovery rates equal to or very nearly equal to the purge rate, there may not be a complete exchange and removal of stagnant water in that portion of the water column above the tubing intake. For this reason, it is important that the tubing intake be placed in the very uppermost portion of the water column while purging. Standard field measurements should frequently be taken during this process to verify adequacy of the purge and readiness for sampling, as described in Section 3.

3.2.1.2 Submersible Pumps

When a submersible pump is used for well purging, the pump itself is lowered into the water column. The pump must be cleaned as specified in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

The pump/hose assembly used in purging should be lowered into the top of the standing water column and not deep into the column. This is done so that the purging will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static volume can be removed. If the pump is placed deep into the water column, the water above the pump may not be removed, and the subsequent samples, particularly if collected with a bailer, may not be representative of the aquifer conditions. It is recommended that no more than three to five feet

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of hose be lowered into the water column. If the recovery rate of the well is faster than the pump rate and no observable draw down occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the recovery rate of the well, the pump will have to be lowered, as needed, to accommodate the drawdown. After the pump is removed from the well, the hose and the pump should be cleaned as outlined in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

3.2.2 Purging With Bailers

Standard-cleaned (SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) closed-top Teflon® bailers with Teflon® coated stainless steel leaders and new nylon rope are lowered into the top of the water column, allowed to fill, and removed. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile organic constituents. The use of bailers for purging and sampling is discouraged because the correct technique is highly operator dependent and improper use may result in an unrepresentative sample.

3.2.3 Field Care of Purging Equipment

New plastic sheeting should be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, ropes, etc., in the event they accidentally come into contact with the ground surface or, for some reason, they need to be placed on the ground during the purging event. It is preferable that hoses used in purging that come into contact with the ground water be kept on a spool or contained in a large wash tub lined with plastic sheeting, both during transportation and during field use, to further minimize contamination by the transporting vehicle or the ground surface.

Careful consideration shall be given to using submersible pumps to purge wells which are excessively contaminated with oily compounds, because it may be difficult to adequately decontaminate severely contaminated pumps under field conditions. When wells of this type are encountered, alternative purging methods, such as bailers, should be considered.

3.2.4 General Low Flow/Low Stress Method Preference

The device with the lowest pump or water removal rate and the least tendency to stress the well during purging should be selected for use. For example, if a bailer and a peristaltic pump both work in a given situation, the pump should be selected because it will greatly minimize turbidity, providing a higher quality sample (Sec.

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3.4.2, Purging When Water Level Is Within Limit of Suction**,** contains a description of low flow purging and sampling with a peristaltic pump used in a temporary well).

3.2.5 Low Flow/Low Volume Purging Techniques/Procedures

An alternative to the low flow/low stress purging method is the low flow/low volume method, commonly referred to as the "micro-purge" method. The low flow/low volume purging method is a procedure developed and used to minimize purge water volumes. The pump intake is placed within the screened interval at the zone of sampling, preferably, the zone with the highest flow rate. Low flow rate purging is conducted after hydraulic conditions within the well have re-stabilized, usually within 24 to 48 hours. Flow rates should not exceed the recharge rate of the aquifer. This is monitored by measuring the top of the water column with a properly cleaned water level indicator or similar device while pumping. This method is not considered to be a standard method by the Branch and is only acceptable under certain hydraulic conditions. It's use must be evaluated on a case-by-case basis.

3.3 Wells With In-Place Plumbing

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Many permanent monitoring wells at active facilities are also equipped with dedicated, in-place pumps. The objective of purging wells with in-place pumps is the same as with monitoring wells without in-place pumps, i.e., to ultimately collect a ground water sample representative of aquifer conditions. Among the types of wells identified in this section, two different approaches are necessary.

A permanent monitoring well with an in-place pump should, in all respects, be treated like a monitoring well without a pump. One limitation is that in most cases the in-place pump is "hard" mounted, that is, the pump is suspended in the well at a pre-selected depth and cannot be moved up or down during purging and sampling. In these cases, well volumes are calculated, parameters are measured and the well is sampled from the pump discharge, after volume removal and parameter conditions have been met.

In the case of the other types of wells, i.e., municipal, industrial and residential supply wells, however, not enough is generally known about the construction aspects of the wells to apply the same criteria as used for monitoring wells, i.e., 3 to 5 well volumes. The volume to be purged in these situations, therefore, depends on several factors: whether the pumps are running continuously or intermittently and whether or not any storage/pressure tanks are located between the sampling point and the pump. The following considerations and procedures should be followed when purging wells with in-place plumbing under the conditions described.

3.3.1 Continuously Running Pumps

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If the pump runs more or less continuously, no purge (other than opening a valve and allowing it to flush for a few minutes) is necessary. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, locate the valve closest to the tank. Measurements of pH, specific conductance, temperature, and turbidity are recorded at the time of sampling.

3.3.2 Intermittently or Infrequently Running Pumps

If the pump runs intermittently or infrequently, best judgment should be utilized to remove enough water from the plumbing to flush standing water from the piping and any storage tanks that might be present. Generally, under these conditions, 15 to 30 minutes will be adequate. Measurements of pH, specific conductance, temperature and turbidity should be made and recorded at intervals during the purge and the final measurements made at the time of sampling should be considered the measurements of record for the event.

3.4 Temporary Monitoring Wells

3.4.1 General Considerations

Procedures used to purge temporary ground water monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15 sampler or a Hydropunch® sampler. As such, the efforts to remove several volumes of water to replace stagnant water do not necessarily apply because stagnant water is not present. It is important to note, however, that the longer a temporary well is in place and not sampled, the more stagnant the water column becomes and the more appropriate it becomes to apply, to the extent possible, standard permanent monitoring well purging criteria to it to re-achieve aquifer conditions.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low stress purging techniques using variable speed peristaltic pumps.

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3.4.2 Purging When Water Level Is Within Limit of Suction

In situations where the elevation of the top of the water column is within the limit of suction (no greater than about 25 feet head difference between the pump and the water level), a variable speed peristaltic pump may be used to purge temporary wells. Enough tubing is deployed to reach the bottom of the temporary well screen. At the onset of purging, the tubing is slowly lowered to the bottom of the screen and is used to remove any formation material which may have entered the well screen during installation. This is critical to ensuring rapid achievement of low turbidity conditions. After the formation material is removed from the bottom of the screen, the tubing is slowly raised through the water column to near the top of the column. The tubing can be held at this level to determine if the pump rate is drawing down the water level in the well. If the water level remains the same, secure the tubing at the surface to maintain this pumping level.

If drawdown is observed on initiation of pumping, reduce the pump speed and attempt to match the drawdown of the well. Sustained pumping at these slow rates will usually result in a relatively clear, low turbidity sample. If the drawdown stabilizes, maintain that level, however, if it continues to lower, "chase" the water column until the well is evacuated. In this case, the recovered water column may be relatively free of turbidity and can be sampled. It may take several episodes of recovery to provide enough volume for a complete sample.

3.4.3 Purging When Water Level Is Greater Than Limit of Suction

In situations where the elevation of the water table is greater than the limit of suction, peristaltic pumps cannot be used to purge temporary wells. If the temporary well is a ScreenPoint15® sampler with small diameter probe rod riser, the only practical choices for water removal are a small diameter bailer, a small diameter bladder pump or an inertial pump. If the well is to be used strictly for VOC screening, it may be acceptable to use the bailer to bail as much sediment from the well as possible prior to sampling. If metals are the analytes of concern, the bladder pump is the best choice for lowering the turbidity of the water column prior to sampling, followed next by the inertial pump. For larger diameter temporary wells, two-inch diameter or greater, bailers and the Grundfos® RediFlo2 may be used although excessive silt or other “fines” may present problems with the operation of the pump.

3.4.4 Considerations for Direct Push Groundwater Sampling

With many of the direct push sampling techniques, purging is either not practical or possible, therefore, no purging is conducted. The sampling device is simply pushed or driven to the desired depth and opened and the sample is collected and retrieved. As a result, some samples collected in this way may not be satisfactory

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or acceptable for certain analyses, i.e., the subject procedure may yield a turbid sample that is not appropriate for metals analyses.

3.5 Investigation Derived Waste

Purging generates quantities of purge water or investigation derived waste (IDW), the disposition of which must be considered. See SESD Operating Procedure for Management of Investigation Derived Waste (SESDPROC-202) for guidance on management or disposal of this waste.

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4 Groundwater Sampling Methods – Sampling

4.1 General

Sampling is the process of obtaining, containerizing, and preserving (if required) a ground water sample after the purging process is complete. Non-dedicated pumps for sample collection generally should not be used. Many pumps are made of materials such as brass, plastic, rubber, or other elastomer products which may cause chemical interferences with the sample. Their principle of operation may also render them unacceptable as a sample collection device. It is recognized that there are situations, such as industrial or municipal supply wells or private residential wells, where a well may be equipped with a dedicated pump from which a sample would not normally be collected. Discretion should always be used in obtaining a sample.

4.2 Sampling Wells With In-Place Plumbing

Samples should be collected following purging from a valve or cold water tap as near to the well as possible, preferably prior to any storage/pressure tanks or physical/chemical treatment system that might be present. Remove any hose that may be present before sample collection and reduce the flow to a low level to minimize sample disturbance, particularly with respect to volatile organic constituents. Samples should be collected directly into the appropriate containers as specified in the ASBLOQAM. It may be necessary to use a secondary container, such as a clean 8 oz. or similar size sample jar or a stainless steel scoop, to obtain and transfer samples from spigots with low ground clearance. Also, refer to the discussion in the SESD Operating Procedure for Potable Water Supply Sampling (SESDPROC-305), Sec. 4.2, Potable Water Samples Collected from Wells with In-Place Plumbing**.** Potable well measurements for pH, specific conductance, temperature, and turbidity should be recorded at the time of sample collection.

4.3 Sampling Wells without Plumbing, Within the Limit of Suction

4.3.1 Equipment Available

The pump of choice for sampling ground water within the limit of suction is the variable-speed peristaltic pump. Its use is described in the following sections. Other acceptable alternatives that may be used under these conditions are the RediFlo2® electric submersible pump (with Teflon® tubing) and a closed-top Teflon® bailer

4.3.1.1 Peristaltic Pump, Direct from Pump Head Tubing

Samples for some constituents, primarily inorganic analytes such as metals and cyanide, may be collected directly from the pump head tubing. This method is acceptable under the following conditions:

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- The pump head tubing must be changed between sampling locations;
- The pump head tubing must be either be certified clean according to SESD's internal quality control program described in Section 3.2 of the SESD Operating Procedure for Field Sampling Quality Control (SESDPROC-011) or
- An equipment rinsate blank is collected by pumping de-ionized water through a piece of the tubing.

4.3.1.2 Peristaltic pump/vacuum jug

It is not acceptable to collect samples for organic compounds analyses through the flexible tubing used in the pump head. When collecting samples for organic compound analyses it is necessary to use a vacuum container, placed between the pump and the well for sample collection. The following step-by-step procedures describe the process of sampling with a peristaltic pump and vacuum jug (see note following these procedures for collection of VOC samples):

1. Disconnect the purge tubing from the pump. Make sure the tubing is securely attached to the protective casing or other secure object.

2. Insert the tubing into one of the ferrule nut fittings of a Teflon® vacuum container transfer cap assembly.

3. Place a suitable length of Teflon® tubing between the remaining transfer cap assembly ferrule nut fitting and the vacuum side of the flexible tubing in the peristaltic pump head. Securely hand-tighten both fittings.

4. Turn the pump on. Water should begin to collect in the transfer container (typically a 1-liter sample container) within a few minutes. If water does not begin to flow into the container within several minutes, check the transfer cap fittings and make sure the assembly is tightly attached to the container. It may be necessary to tighten the ferrule nuts with a wrench or pliers to achieve a vacuum in the system, particularly when approaching the maximum head difference between the pump and water table (limit of suction).

5. When the transfer container is nearly full, turn off the pump, remove the transfer cap assembly, and pour the sample into the appropriate containers. Because the 1-liter containers used by the Branch are rinsed with nitric acid during cleaning, they cannot be used for collecting samples to be analyzed for nitrogen sensitive parameters.

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6. If additional sample volume is needed, replace the transfer cap assembly, turn the pump on, and collect additional volume. The use of Teflon® valves or ball check devices to retain the water column in the sample delivery tubing during the transfer phase, when large volumes of sample are required, is acceptable. These devices, however, must be constructed so that they may be completely disassembled and cleaned according to the procedures in SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205).

7. When sampling is completed, all Teflon® tubing should be discarded.

   NOTE: Samples for volatile organic compound analyses cannot be collected using this method. If samples for VOC analyses are required, they must be collected with a Teflon® or stainless steel bailer or by other approved methods, such as the "soda straw" method. The "soda straw" method involves allowing the tubing to fill, by either lowering it into the water column (A) or by filling it via suction applied by the pump head (B). If method (A) is used, the tubing is removed from the well after filling and the captured sample is allowed to drain into the sample vial. If method (B) is used, after running the pump and filling the tubing with sample, the pump speed is reduced and the direction reversed to push the sample out of the tubing into the vials. Avoid completely emptying the tubing when filling the sample vials when using method (B) to prevent introducing water that was in contact with the flexible pump head tubing. Either method is repeated, as necessary, until all vials are filled.

4.3.1.3 RediFlo2® Electric Submersible Pump (with Teflon® tubing)

After purging has been accomplished with RediFlo2® electric submersible pump, the sample may be obtained directly from the pump discharge, provided that Teflon® tubing was used for the sample delivery line. The discharge rate of the pump should be reduced during volatile organic compound sample collection to minimize sample disturbance. Note, if the RediFlo2® electric submersible pump is used for sampling, the water in the cooling chamber must be replaced with organic-free water between each well and the pump must undergo a full external and internal cleaning. In addition, pump rinsate blanks must be collected, at the appropriate frequency, to demonstrate that the pump has been adequately cleaned between wells.

4.3.1.4 Bailers

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New bailer rope should be attached to the bailer via a Teflon® coated stainless steel wire. (If a bailer was used to purge the well, it may also be used to sample the well and new bailer rope is not required between purging and sampling). The bailer should be gently immersed in the top of the water column until just filled. At this point, the bailer should be slowly removed and the contents emptied into the appropriate sample containers.

4.4 Sampling Wells without Plumbing, Exceeding the Limit of Suction

All methods described previously in Section 4.3.2.1.3, RediFlo2® Electric Submersible Pumps, and Section 4.3.2.1.4, Bailers, are suitable sample methods where the water table is too deep to consider the use of a peristaltic pump for sampling.

4.5 Sample Preservation

After sample collection, all samples requiring preservation must be preserved as soon as practical. Consult the ASBLOQAM for the correct preservative for the particular analytes of interest. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample. Samples requiring reduced temperature storage should be placed on ice immediately.

4.6 Special Sample Collection Procedures

4.6.1 Trace Organic Compounds and Metals

Special sample handling procedures should be instituted when trace contaminant samples are being collected. All sampling equipment, including pumps, bailers, water level measurement equipment, etc., which comes into contact with the water in the well must be cleaned in accordance with the cleaning procedures described in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination (SESDPROC-205 or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206). Pumps should not be used for sampling unless the interior and exterior portions of the pump and the discharge hoses are thoroughly cleaned. Blank samples should be collected to determine the adequacy of cleaning prior to collection of any sample using a pump other than a peristaltic pump.

4.6.2 Order of Sampling with Respect to Analytes

In many situations when sampling permanent or temporary monitoring wells, an adequate purge, with respect to turbidity, is often difficult to achieve. Removal

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and insertion of equipment after the purge and prior to actual sampling may negate the low turbidities achieved during purging and elevate turbidity back to unacceptable levels. For this reason, it is important that special efforts be used to minimize any disturbance of the water column after purging and to collect the aliquot for metals first. Therefore, the preferred order of sampling is metals first, followed by other inorganic analytes, extractable organic compounds and volatile organic compounds.

4.6.3 Filtering

As a standard practice, ground water samples will not be filtered for routine analysis. Filtering will usually only be performed to determine the fraction of major ions and trace metals passing the filter and used for flow system analysis and for the purpose of geochemical speciation modeling. Filtration is not allowed to correct for improperly designed or constructed monitoring wells, inappropriate sampling methods, or poor sampling technique.

When samples are collected for routine analyses and are filtered, both filtered and non-filtered samples will be submitted for analyses. Samples for organic compounds analysis should not be filtered. Prior to filtration of the ground water sample for any reason other than geochemical speciation modeling, the following criteria must be demonstrated to justify the use of filtered samples for inorganic analysis:

1. The monitoring wells, whether temporary or permanent, have been constructed and developed in accordance with the SESD Guidance Document, Design and Installation of Monitoring Wells (SESDGUID-001).

2. The ground water samples were collected using sampling techniques in accordance with this section, and the ground water samples were analyzed in accordance with USEPA approved methods.

3. Efforts have been undertaken to minimize any persistent sample turbidity problems. These efforts may consist of the following:

- Redevelopment or re-installation of permanent ground water monitoring wells.
- Implementation of low flow/low stress purging and sampling techniques.

4. Turbidity measurements should be taken during purging and sampling to demonstrate stabilization or lack thereof. These measurements should be documented in the field notes. If the ground water sample appears to have either a chemically-induced elevated turbidity, such as would occur with precipitate formation, or a naturally elevated colloid or fine, particulate-related turbidity, filtration will not be allowed.

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If filtration is necessary for purposes of geochemical modeling or other **pre-approved** cases, the following procedures are suggested:

1. Accomplish in-line filtration through the use of disposable, high capacity filter cartridges (barrel-type) or membrane filters in an in-line filter apparatus. The high capacity, barrel-type filter is preferred due to the higher surface area associated with this configuration. If a membrane filter is utilized, a minimum diameter of 142 mm is suggested.

2. Use a 5 μm pore-size filter for the purpose of determining the colloidal constituent concentrations. A 0.1 μm pore-size filter should be used to remove most non-dissolved particles.

3. Rinse the cartridge or barrel-type filter with 500 milliliters of the solute (ground water to be sampled) prior to collection of sample. If a membrane filter is used, rinse with 100 milliliters of solute prior to sample collection.

Potential differences could result from variations in filtration procedures used to process water samples for the determination of trace element concentrations. A number of factors associated with filtration can substantially alter "dissolved" trace element concentrations; these include filter pore size, filter type, filter diameter, filtration method, volume of sample processed, suspended sediment concentration, suspended sediment grain-size distribution, concentration of colloids and colloidally-associated trace elements, and concentration of organic matter. Therefore, consistency is critical in the comparison of short-term and long-term results. Further guidance on filtration may be obtained from the following: 1) Metals in Ground Water: Sampling Artifacts and Reproducibility; 2) Filtration of Ground Water Samples for Metals Analysis; and 3) Ground Water Sampling - A Workshop Summary. See Section 1.4, References, for complete citation for these documents.

Bacterial Sampling

Whenever wells (normally potable wells) are sampled for bacteriological parameters, care must be taken to ensure the sterility of all sampling equipment and all other equipment entering the well. Further information regarding bacteriological sampling is available in the following: 1) Sampling for Organic Chemicals and Microorganisms in the Subsurface; 2) Handbook for Evaluating Water Bacteriological Laboratories; and 3) Microbiological Methods for Monitoring the Environment, Water and Wastes. See Section 1.4, References, for complete citation for these documents.

4.7 Specific Sampling Equipment Quality Assurance Techniques

All equipment used to collect ground water samples shall be cleaned as outlined in the SESD Operating Procedure for Field Equipment Cleaning and Decontamination

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(SESDPROC-205) or SESD Operating Procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206) and repaired, if necessary, before being stored at the conclusion of field studies. Cleaning procedures utilized in the field or field repairs shall be thoroughly documented in field records.

4.8 Auxiliary Data Collection

During ground water sample collection, it is important to record a variety of ground water related data. Included in the category of auxiliary data are water levels measured according to the SESD Operating Procedure for Groundwater Level and Well Depth Measurement (SESDPROC-105), well volume determinations (Section 3.1.1, Purging and Purge Adequacy), pumping rates during purging (see below), and occasionally, drillers or boring logs. This information should be documented in the field records.

4.8.1 Well Pumping Rate - Bucket/Stop Watch Method

The pumping rate for a pump can be determined by collecting the discharge from the pump in a bucket of known volume and timing how long it takes to fill the bucket. The pumping rate should be in gallons per minute. This method shall be used primarily with pumps with a constant pump rate, such as gasoline-powered or electric submersible pumps. Care should be taken when using this method with some battery-powered pumps. As the batteries' charge decreases, the pump rate also decreases so that pumping rate calculations using initial, high pump rates may be erroneously high. If this method is used with battery-powered pumps, the rate should be re-checked frequently to ensure accuracy of the pumping rate calculations.

Standard Operating Procedures for Analysis of Total Chlorinated Ethenes in Soil and Groundwater Using the Color Tec Screening Method

Description

This SOP describes a field screening method for determining total chlorinated ethene concentrations in the headspace above soil and groundwater samples. The method employs colorimetric gas detector tubes to analyze the headspace gases. To conduct the method, groundwater or a soil and water mixture are placed in a standard 40 mL VOA vial and capped. The sample vial is then agitated vigorously for 20 seconds. Using a manual vacuum pump, two hollow needles, and Tygon® tubing, the headspace vapor is purged from the vial through the colorimetric gas detector tube. The tips of the needles are positioned so that one is in the headspace area and one is submerged at the bottom of the vial. As air is drawn from the headspace through one needle, ambient air is allowed into the bottom of the vial through the other needle. This process purges the VOCs from the water so no headspace calculation using Henry's Constant is required.

Each colorimetric tube contains a catalyst that decomposes the chlorinated ethene, releasing hydrogen chloride, which discolors the reagent (4-phenylazo-diphenylamine) in the tube. Any color change within the detector tube indicates the presence of a chlorinated ethene. The detector tubes are constructed of glass and printed with calibration scales to facilitate measurement of the linear extent of the reaction within the tube. The manufacturer of the tubes (Gastec®) provides tubes for a variety of concentration ranges. The lowest concentration range tube is used initially to screen the sample. When a positive result is observed, the concentration level is obtained by matching the linear extent of the discolored reagent inside the tube to the calibration scale printed on the outside of the tube. If the calibrated range of the tube is exceeded by the reaction, a tube with a higher concentration range is used to screen a duplicate sample. This procedure is repeated until the approximate concentration is determined.

Safety Precautions

Safety glasses should be worn whenever handling potentially contaminated soil or water.

Analysis Procedure

Materials Needed

Gastec® hand pump or equivalent
Extra low, low, medium, and high range Gastec® colorimetric tubes
Plastic male luer lock threaded fitting with ⅛-in hose barb
Plastic male luer non-threaded fitting with ⅛-in hose barb
Tygon® lab tubing ⅛-in ID × ¼-inch OD
Deflected noncoring septum penetration needle (18G × 4)
Hot plate
Test tube rack
Vortex mixer
Charcoal prefilter tubes
40 mL clear VOA with Teflon-silicon septa
Kimwipes™

Reagents Needed

For soil samples, 20 mL ultra-pure deionized water per sample
Chlorinated ethene QC standard
Decontamination materials

Pitfalls

- The color change indicated by a sample containing less than 10 µg/L PCE or less than 30 µg/L vinyl chloride is very subtle and could be missed by an inexperienced operator. The solution to this problem is practice and careful examination of each tube after pumping.

- Introduction of water vapor into the tube past the catalyst stage could indicate a low level false positive to an inexperienced operator. However, water-induced false positives are easily recognized by an experienced operator and are avoidable through proper placement of the extraction needle in the VOA vial.

- If chlorinated tap water is used in the soil sample screening procedure, the free chlorine in the tap water could (theoretically) indicate a low-level false positive in the soil sample. The potential for producing a false reading in this manner can be avoided by using ultrapure deionized water during the soil sample screening procedure.

- Do not use hydrochloric acid as a preservative when using this method.

Procedure

Water

1. Fill 40 mL VOA vial with 24 ml (about 60 percent of volume) of groundwater sample and cap.

2. Shake the sample vigorously for 20 seconds.

3. Penetrate the septum with a needle equipped with the charcoal pre-filter tube and position the needle point near the bottom of the vial.

4. Penetrate the septum with the extraction needle attached to the Tygon® tubing. Ensure that the needle tip is well clear of the water surface.

5. Break one end of the detection tube and attach it to the Tygon® tubing.

6. Break the other end of the detection tube and attach it to the hand pump.

7. Begin drawing air from the vial and observe any change in color in the tube.

8. Record the concentration reached by the change in color on the scale marked on the tube.

Soil

1. Fill 40-ml VOA vial with approximately 10 cc of soil and 10 ml of ultrapure deionized water (about 50-70 percent of volume) and cap.

2. Shake the sample vigorously for 20 seconds.

3. Penetrate the septum with a needle equipped with a charcoal pre-filter tube and position the needle point near the top of the soil.

4. Penetrate the septum with a needle attached to the Tygon® tubing. Ensure that the needle tip is well clear of the water surface.

5. Break one end of the detection tube and attach it to the Tygon® tubing.

6. Break the other end of the detection tube and attach it to the hand pump.

7. Begin drawing air from the vial and observe any change in color in the tube.

8. Record the concentration reached by the change in color on the scale marked on the tube.

Detection Limits

The practical quantitation limit for PCE is 5-10 ppb as measured in the headspace. This method does not employ Henry's Constant or other partitioning methods to back calculate the actual concentrations in the soil or water sample. Samples containing only trans-1,2-dichloroethene, 1,1-dichloroethene, or vinyl chloride are generally not detectable with ColorTec at concentrations below 25 µg/L.

General Interferences

Other compounds including bromine, free chlorine, and hydrogen chloride can also indicate a positive reaction within the detector tube.

The Gastec® tubes are sold to detect specific chlorinated alkenes. However, if there are other chlorinated ethenes present in a sample, the identification of a specific chlorinated compound is not possible using the ColorTec method. The developers of the ColorTec method recommend using the Gastec® tetrachloro-ethene tubes for all sampling.

The detector tubes are designed to be used at temperatures of 0 to 40 °C (32 to 104 °F) and are calibrated based on a tube temperature (not sample temperature) of 20 °C (68 °F). There is a significant reduction in sensitivity of the tubes when sustained ambient air temperatures are significantly lower than 20 °C while conducting the method. The reduction in the temperature of the reagent decreases the reaction time resulting in a less visible color change within the tube. Conversely, when ambient temperatures are in excess of 20 °C, the tubes may be hypersensitive. The following correction factors provided by Gastec® can be applied to the readings to correct for sustained ambient temperatures other than 20 °C or 68 °F:

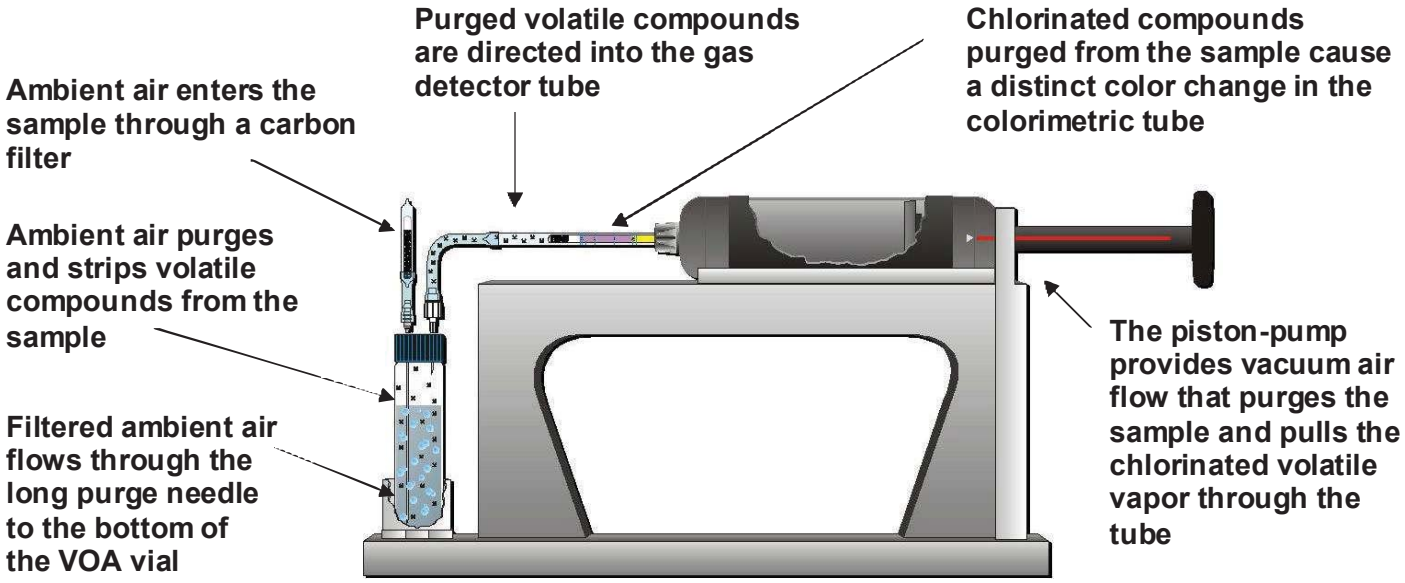
Temperature	0 °C (32 °F)	10 °C (50 °F)	20 °C (68 °F)	30 °C (86 °F)	40 °C (104 °F)
Correction Factor	× 2	× 1.3	× 1	× 0.7	× 0.55

Because tube/sample temperatures below 20 °C significantly reduce the sensitivity of the method, it is recomended that the prepared sample vials and colorimetric tubes (prior to breaking the tips) be heated using a hot water bath prior to screening when ambient temperatures are below 20 °C.

Method Procedures Manual

Field-Based Analysis of Chlorinated Volatile Organic Halocarbons

- **AQR Color-Tec® combines sample purging with direct-read gas detector tubes to quickly detect low-levels of chlorinated compounds in liquid and solid samples.**
- **AQR Color-Tec® detects concentrations of total chlorinated volatile organic halocarbons (CVOHs) below 3 µg/L in water and 3 µg/Kg in soil samples.**
- **AQR Color-Tec® provides fast, low-level, economical, decision-quality data which maximizes sampling frequency and sampling coverage to locate source areas and delineate dissolved-phase contaminant plumes.**
- **Samples are analyzed by purging the volatile compounds from either liquid or solid samples through a colorimetric detector tube, which produces a distinct color change when exposed to any chlorinated compound.**



AQR Color-Tec® Contact and Ordering Information

- For more information visit www.aqrcolortec.com
- For kit orders contact Phil Pecevich at 919-918-7191
- For technical support and training contact Perry Kelso at pkelso@aqrcolortec.com

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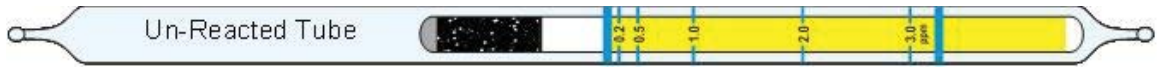
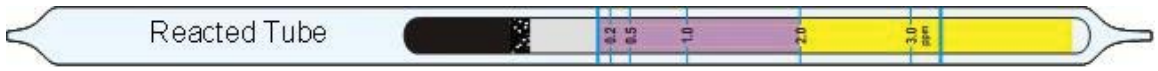
1.0 Method Principle

AQR Color-Tec® is a field-based analytical method which combines the use of colorimetric gas detector tubes (originally designed for occupational breathing-zone monitoring) with sample purging to detect very low (<3 µg/L or µg/Kg) concentrations of chlorinated volatile organic halocarbons (CVOHs) in liquid and solid samples. Samples are analyzed by purging the volatile compounds from a groundwater or soil sample through the colorimetric tube, which is designed to produce a distinct color change when exposed to chlorinated compounds. Estimated sample concentrations are obtained by comparing the tube readings to a conversion table based on comparing AQR Color-Tec and GC/MS split sample data.

Each colorimetric tube contains an oxidizer (PbO_2) and a catalyst (H_2SO_4) which decomposes and converts the chlorinated compounds to hydrogen chloride, which discolors a reagent (4-phenylazodiphenylamine) in the tube from yellow to purple. The reaction formula provided by Gastec® for the PCE tube is as follows:



$$Cl_2C{:}CCl_2 + PbO_2 + H_2SO_4 \rightarrow HCl$$
$$HCl + \text{(4-Phenolazo) Diphenylamine} \rightarrow \text{Chloride}$$



The colorimetric tubes react positively to all chlorinated volatile organic halocarbons, including saturated and unsaturated chlorinated alkenes and alkanes. The total response indicated by the detector tube reflects the sum of the concentration of each individual chlorinated compound present in the sample. The method is primarily qualitative (detects the presence/absence of a compound or class of compounds).

The colorimetric gas detector tubes used in the method are designed to detect CVOHs in ambient air. Color-Tec is an alternate use of these tubes, which purges CVOHs from a water or soil sample and concentrates them into the colorimetric tube. When using colorimetric tubes for the Color-Tec method, the units (ppmV) printed on the tubes do not directly reflect the quantity of CVOHs dissolved in the water or soil sample being analyzed. The Color-Tec reading (the distance that the color change travels through the tube) is a relative response to the amount of chlorinated-compound molecules that have been purged from the sample and directed into the tube. Therefore, the units printed on the tubes are used only to record the relative response for each analysis in order to facilitate comparison of the response for comparison to laboratory GC/MS methods. The relative response (Color-Tec reading) is not the concentration in ppmv (as printed on the tubes), but rather a unit-less value which must be compared to known values in order to yield an estimate of the actual concentration present in the sample using a conversion table developed by comparison of AQR Color-Tec® tube responses to GC/MS split-sample analyses conducted on thousands of samples.

2.0 AQR Color-Tec® Test Kit Description and Set-up

The AQR Color-Tec® Chlorinated VOH Soil/Water Test Kit System consists of three primary components:

1. **Hardware Kit** - Contains reusable equipment and carrying case;
2. **20-Sample Expendables Kit** - Contains all disposable components needed for analysis of 20 water or soil samples using low range (133-LL) tubes, plus medium range (133-L) tubes and high range (133-M) tubes for re-analyzing samples that exceed the concentration range of the low range (133-LL) tubes;
3. **QA/QC Kit** – Contains components needed to perform basic QA/QC procedures to insure method performance and provide method confidence.

2.1 Materials Provided

2.1.1 AQR Color-Tec® Hardware KIT (See Figure 1)

Item	Quantity
Piston pump	1
AQR Color-Tec® Pump Stand	1
Corning® Hot Plate	1
Stainless Steel Heating Pan	1
Nalgene® VOA Heating Rack	1
Thermometer	1
Decontamination Syringe	1

2.1.2 AQR Color-Tec® 20-Sample Expendables Pack (See Figure 2)

(Analyzes 20 water or soil samples)

Item	Quantity
Low-Range (133LL) Colorimetric Detector Tubes	20
Medium-Range (133L) Colorimetric Detector Tubes	3
High-Range (133M) Colorimetric Detector Tubes	2
Disposable Extraction Needle Assemblies **(single use only)**	25
40 Milliliter VOA Vials – empty (for samples)	40
Carbon Filter (may be re-used)	2
Carbon Filter Luer Assembly (may be re-used)	2
Purge Needle (may be re-used)	2
Nitrile Safety Gloves (pair)	1

2.1.3 AQR Color-Tec® QA/QC Test Pack (See Figure 3)

(Supplies for conducting all QA/QA procedures described in Section 8)

Item	Quantity
Low-Range (133LL) Colorimetric Detector Tubes	5
Toluene colorimetric Detector Tube	1
60µg/L-TCE reference standard in flame-sealed ampoule	2
300µg/L-TCE reference standard in flame-sealed ampoule	1
600µg/L-TCE reference standard in flame-sealed ampoule	1
10 ml Pipette (for transferring standards)	4
40 ml VOA Vials (empty – (for toluene test samples)	2
40 ml VOA Vials (pre-filled with organic-free water)	4
Disposable Extraction Needle Assemblies **(single use only)**	5
Purge Needle (may be re-used)	1
Carbon Filter (may be re-used)	1
Carbon Filter Luer Assembly (may be re-used)	1
Nitrile Safety Gloves (pair)	1

Figure 1
AQR Color-Tec® Hardware Kit

Figure 2
AQR Color-Tec® 20-Sample Expendables Pack

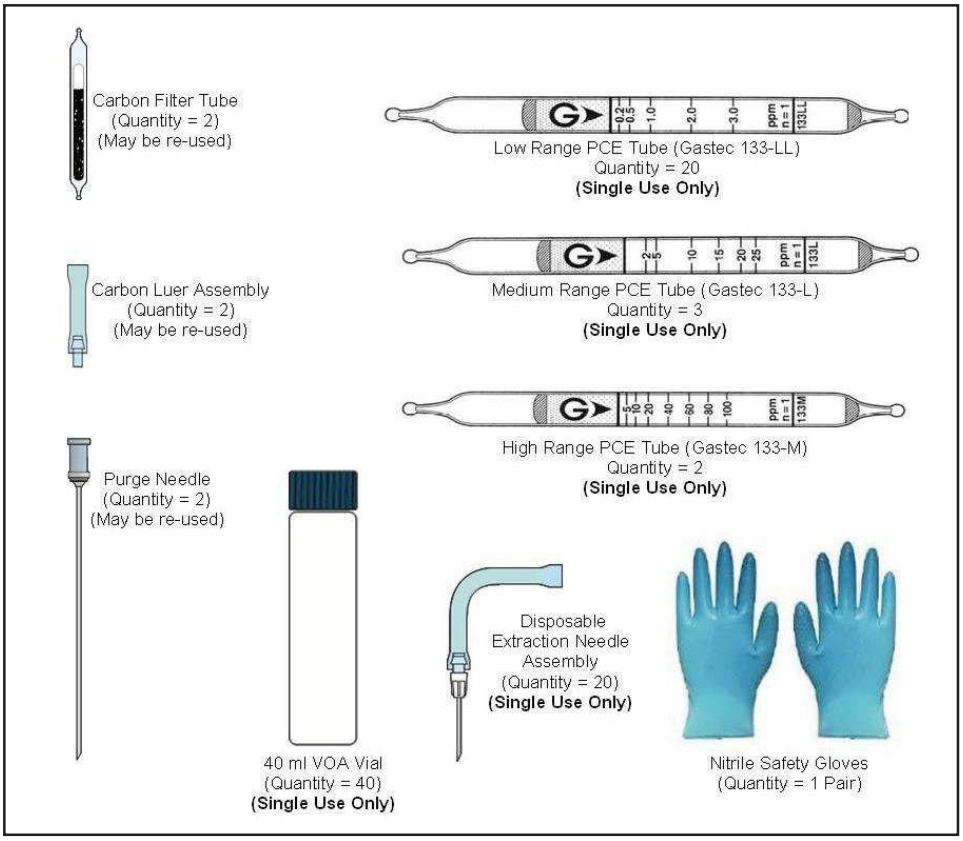
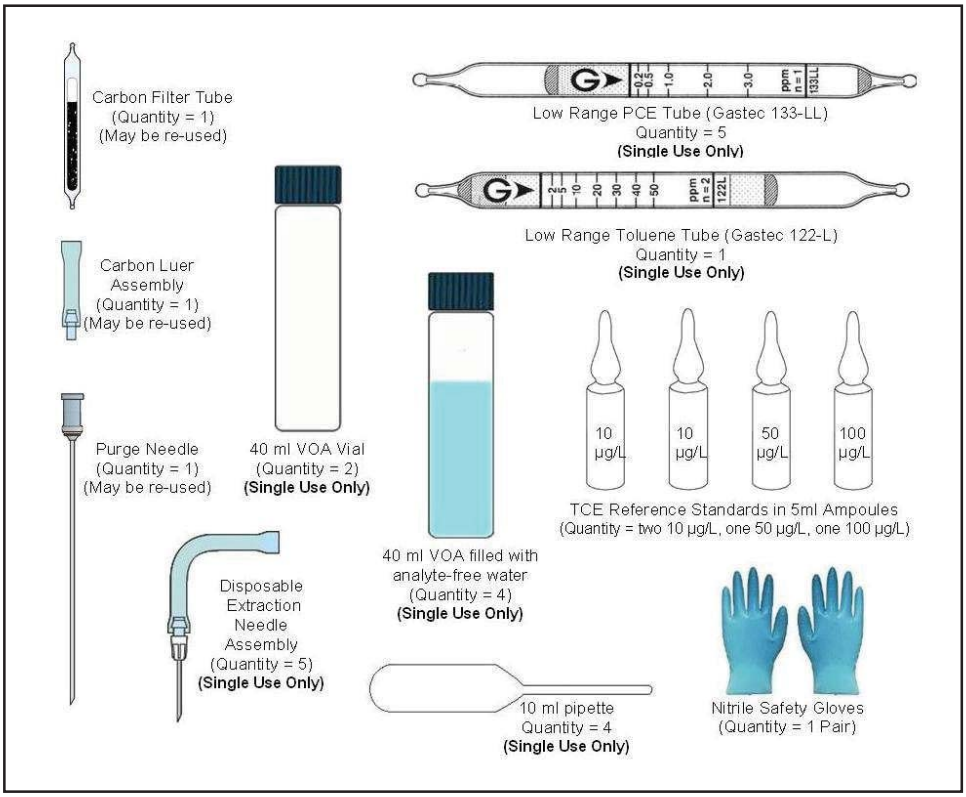


Figure 3
AQR Color-Tec® QA/QC Test Pack



2.2 Accessories Supplied by User

The following items (not provided in the AQR Color-Tec® kit) are suggested for use with the AQR Color-Tec® method to perform the listed functions.

Item	Purpose
Organic-free water	for soil sample extraction and equipment decontamination
Additional safety gloves	personal protection
Safety glasses	personal protection
120V AC power source	for hot plate
Permanent marker	labeling sample bottles
40 Milliliter VOA Vials	for split samples to be analyzed by laboratory methods

The VOA vials used to perform the AQR Color-Tec® method are provided in each kit (two vials per sample). The user may wish to collect a quantity of split samples for laboratory analysis to provide comparison data which may be used to determine site-specific method detection limits and/or to tentatively quantify AQR Color-Tec® results.

2.3 Storage & Stability of Colorimetric Tubes and Reference Standard Ampoules

The Gastec colorimetric tubes have a shelf-life of two years with refrigeration. Tubes should be stored at or below a temperature of 10°C/50°F when not in use. Colorimetric detector tubes are single-use (one tube per analysis) and should be used immediately after the tips are broken. Tube readings should be recorded immediately following analysis because the intensity of the color-change fades over time. Each box of tubes has an expiration date printed in red ink on the top of each box. When heating the tubes for use with the AQR Color-Tec® method, it is recommended that the tube temperature does not exceed 40°C/104° F.

Other procedures and guidelines associated with the use of the tubes for their designed purpose (gas detection in ambient air) are included in the tube manufactures data sheets and tube instructions included in the tube packaging.

The QA/QC reference standards are provided in 5ml flame sealed ampoules to prevent loss of volatiles and generally have a shelf life of one year with refrigeration.

2.4 Heating Colorimetric Tubes and Samples

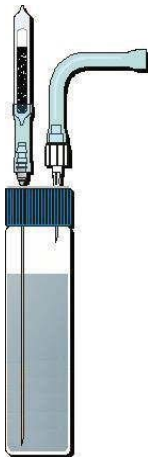
The colorimetric gas detector tubes used in the AQR Color-Tec® method were designed for the purpose of detecting volatile organic compounds (CVOHs) in **ambient air**. When using the tubes for analysis of **ambient air**, the calibrated operating temperature is 20°C/68°F. Using the tubes at temperatures above or below 20°C/68°F, for the purpose of testing **ambient air**, introduces error into the measurements requiring application of correction factors to correct that error. Because Color-Tec is an alternate use of the colorimetric tubes which concentrates CVOHs from water or soil samples into the tubes, the units (ppmV) printed on the tubes have no direct relationship to the quantity of CVOHs dissolved in the water/soil sample being analyzed and the temperature correction factors used for analysis of **ambient air** are not required when using the colorimetric tubes as part of the AQR Color-Tec® method.

However, since the colorimetric tubes are more sensitive to the presence of chlorinated compounds at 40°C/104°F, and the purpose of the AQR Color-Tec® method is to detect the presence/absence of CVOHs in water at concentrations at the lowest concentrations possible, the tubes be heated to their optimum sensitivity (40°C/104°F) to maximize their detection capability. The samples are also heated to maximize the transfer of CVOHs from the water sample to the colorimetric tube.

To heat the samples and colorimetric tubes, a hot plate is used to heat a water bath containing a test tube rack to hold the sample-filled VOA vials and unbroken colorimetric tubes (see Figure 1). Special attention must be paid to the temperature of the water to avoid prolonged overheating the samples and tubes. The samples and colorimetric tubes should not be heated in excess of 40°C/104°F.

Given the size of the heating pan and VOA rack, generally only 3 sets of samples are heated at the same time. When a pair of VOAs is removed from the heating rack and placed on the pump stand, it can be replaced with a new pair for heating. After collection, samples should remain in a cool place until ready to be heated and analyzed. It is recommended to avoid heating the samples for more than about 2 minutes to avoid loss of CVOCs.

2.5 Carbon Pre-Filter



Because ambient air is used to purge the samples, a carbon pre-filter is provided for attachment to the purge needle to prevent possible airborne contaminants from passing through the sample and entering the detector tube during the purging process. To use the carbon pre-filter, break both tips of a carbon filter tube and insert the end of the tube onto the carbon lure assembly (make sure the air-flow arrows on the carbon tube point toward the carbon lure assembly), then tightly insert the male lure fitting on the carbon lure assembly into the female lure fitting on the purge needle (see Figure 2). At sites where little or no ambient air contamination is present, a single pre-filter tube may be reused for several days. However, at sites where high concentrations of airborne chlorinated compounds are suspected or have been confirmed in the ambient air, the pre-filter tubes may need to be replaced more frequently. For most situations, one carbon filter per 20 samples is more than sufficient.

2.6 AQR Color-Tec® Work-Station Set-up

Pump Stand Set-up

1. Place the pump stand up-right on a flat stable surface.
2. Place the ® piston-pump into the curved tray on the top of the pump stand as shown.

Corning® Hot Plate Set-up

1. Connect the AC power cord to the back of the hot plate.
2. Connect the other end of the AC power cord to a USA 120VAC electric outlet.
3. Place the hot plate on a flat stable surface.
4. Set the hot plate thermostat control to between dial setting 4 and 5.

Hot Water Bath Set-up

1. Fill the stainless-steel water bath pan with tap water to approximately 1.5-inches from the rim.
2. Insert the VOA rack into the water-filled, stainless-steel, water bath pan.
3. Remove the cap from a 40ml VOA vial, fill the VOA vial with tap water and place it into the VOA Rack as shown. *Note: The bottom of the water-filled VOA vial should be slightly submersed in the water in the stainless-steel pan.*
4. Place the stainless-steel water bath pan onto the heating surface of the hot-plate.
5. Open a box of low-level (133LL) Gastec® tubes and place several tubes into the water-filled VOA vial. Insert the yellow reagent end of the tubes into the bottom of the VOA vial. Note: Do not place tubes with broken tips in the water bath – heating must be accomplished before breaking the tube tips.
6. Turn on the Oakton® digital thermometer and place the steel probe into the water-filled VOA vial with the colorimetric tubes.
7. Once the water bath reaches a temperature of approximately 100ºF, the colorimetric tubes and VOA vials containing samples can be heated. *Note: The temperature of the water bath should not exceed 100ºF.*

Heating Samples

1. Place both VOA vials containing the sample into the hot water bath for approximately 1 to 2 minutes.
2. Be sure that the VOA vials are tightly sealed before heating. *Note: When properly heated, the VOA vials should feel warm in the hand – DO NOT OPEN VOA VIALS AFTER HEATING.*

Carbon Filter/Purge Needle Set-up

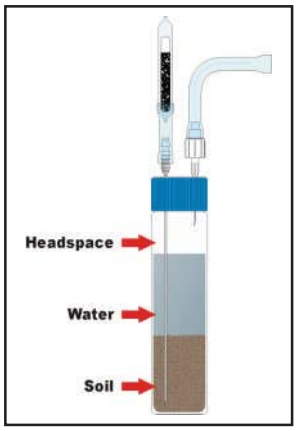
1. Break both ends of a carbon filter tube using the tip breaker on the piston pump.
2. Connect a carbon filter luer assembly to the carbon filter tube by sliding the open end of the vinyl tubing over the broken end of the carbon filter tube. Note: The carbon filter is re-used for multiple purge cycles.
3. Attach the carbon filter assembly to a purge needle by inserting the carbon filter assembly luer fitting into the purge needle luer fitting.
4. The purge needles are re-used after decontamination. Thoroughly clean and rinse the purge needle between each sample analysis to avoid contaminant carryover.

3.0 Sample Collection and Preparation

3.1 Liquid Sample Media

Collect the water or other liquid sample media directly from your sampling device into two 40 ml VOA vials by filling each vial to ~75% capacity (i.e. to about 1-inch below the shoulder of each vial). Tightly secure the caps onto the partially-filled VOA vials. The VOA vials containing the liquid sample to be tested must contain an air-filled headspace to accommodate purging. The caps must be tightened sufficiently to prevent loss of CVOHs during the time between sample collection and analysis (which includes the heating process) and to prevent air leakage during the purging process.

3.2 Solid Sample Media



Place about 1.5 inches of soil (or other solid sample media) into the bottom of each of two VOA vials (i.e. approximately 30 grams in each vial). Immediately after inserting the soil (or other solid sample media) into the two vials, add organic-free or other "clean" water to each VOA vial until they are both ~70 % full (i.e. to approximately 1-inch below the shoulder of each vial). Tightly secure the caps onto the partially-filled VOA vials. Once the caps are secure, shake the VOA vials vigorously for approximately for 5 to 10 seconds to thoroughly mix the soil and water. Additional mixing may be necessary for soil matrices comprised of clay-sized particles. The purpose of the mixing is to transfer any chlorinated compounds suspended in the soil matrix to the water to facilitate more effective purging.

IMPORTANT NOTE: The VOA vials containing the solid sample media and "clean" water must contain an air-filled headspace to accommodate purging. The caps must be tightened sufficiently to prevent loss of CVOHs during the time between sample collection and analysis (which includes the heating process) and to prevent air leakage during the purging process.

3.3 Purpose of the Duplicate Sample

The AQR Color-Tec® method is designed for use with two VOA vials (an original and a duplicate) for each sample collected. In certain situations, the duplicate sample may not be used in the performance of the method. However, the duplicate sample should always be collected in the event that it is needed to complete the analysis process. The duplicate sample may be used in either of the following situations:

- When the initial test does not induce a color change in the colorimetric tube, the second VOA vial containing the duplicate sample, may be purged (using the same colorimetric tube) to increase the probability of detecting very low (< 10 µg/L) concentrations.

- When the initial test induces a color change that exceeds the upper limit of the LL tube (a tube reading > 3), the extra VOA vial can be used to analyze the sample using higher range colorimetric tubes (133L or 133M) to tentatively quantify the higher concentration of chlorinated compounds in the sample.

4.0 Sample Analysis Procedure

1. Place both heated VOA vials (original & duplicate sample) into the two VOA holders on the pump-stand.
2. Remove a low-level tube from the hot water bath and wipe it dry.
3. Break both ends of the colorimetric tube using the tip breaker on the piston pump.
4. Insert the colorimetric tube into the pump inlet with the flow arrow (printed on the tube) toward the pump. ***Note:*** *Tube orientation is critical – the yellow reagent end of the tube is inserted in the pump.*
5. Connect a new extraction needle assembly to the colorimetric tube by sliding the open end of the vinyl tubing over the broken end of the colorimetric tube. This step must be completed before inserting the needle into the VOA (Prior to step 6).
6. Remove the protective cap from the extraction needle and insert the needle into the septa of the first VOA vial. ***Note:*** *Be sure that the tip of the extraction needle is positioned within the headspace of the VOA vial (above the water level). Do not insert the extraction needle as far as it will go into the headspace of the VOA vial, but rather only to a point slightly beneath the inside of the septa to reduce the possibility of sample water entering the extraction needle assembly and colorimetric tube during the purging process.*

7. Insert the purge needle into the septa of the first VOA vial – push the tip needle to the bottom of the VOA vial. **IMPORTANT NOTE: Do not insert the purge needle before completing steps 5 and 6.**
8. Align the 50ml label and red dot on the pump handle with the red dot on the pump shaft.
9. Pull the handle sharply until it locks in the 50ml (half pull) position.
10. Confirm that air is purging through the sample in the VOA vial.
11. Purge for approximately 30 seconds.
12. Check the yellow reagent in the tube for a color-change.
13. If no color-change reaction is visible or if the color reading is less than 1.5, rotate the pump handle ½ turn and pull the handle out to lock in the 100ml position.
14. Continue the 100ml purge until the flow cycle is complete. Note: Flow is complete when the end-of-flow indicator (located on the back of the pump handle) returns to its full brightness.

15. Check the yellow reagent phase in the tube for a color change.
16. If no color-change is visible, remove the extraction needle from the VOA with the vinyl tubing still attached to the low-level tube, rotate the pump handle ¼ turn and push the plunger back into the pump, remove the extraction needle from the first VOA vial and inject it into the septa of the second VOA (duplicate sample), then remove the purge needle from the first VOA vial and inject it into the septa of the second VOA (duplicate sample) - now re-pull the pump handle to lock into the 100ml position.
17. When the second 100ml purge cycle is complete, read and record the results.

For samples containing high concentrations (>150 µg/L) the resulting color-change may exceed the calibrated limit of the low-level tube, requiring the second VOA vial (duplicate sample) to be purged and analyzed by repeating steps 3 through 13 using a medium range (133L) or a high range (133M) tube.

For samples containing low (<5 µg/L) concentrations the color change does not usually begin until 100 CCs of air have purged through the sample. Furthermore, the color change induced at these low concentrations is very slight (below 0.5 on the tube scale) and appears as a slight darkening or light purple hue at the entrance of yellow reagent layer in the LL tube. When the sample contains higher concentrations (>10 µg/L) of chlorinated compounds, the resulting color change is an obvious light to dark purple, which propagates through the yellow reagent layer toward the pump end of the colorimetric tube. The tube reading (Color-Tec response) is obtained by matching the linear extent of the discolored reagent inside the tube to the calibration scale printed on the outside of the tube. Table 1 presents a troubleshooting matrix with causes and solutions potential problems.

Important Procedure Notes:

The disposable extraction Needle assembly is intended for one use only. Decontamination and re-use of this part is highly discouraged because of the risk of contaminant carryover from the tubing and other plastic parts which can harbor contaminants from the previous analysis.

Never insert the purge needle into the VOA before the extraction needle assembly has first been connected to the colorimetric tube and inserted into the VOA headspace. If the purge needle is inserted first, the pressure inside the sealed VOA may force sample water up though the purge needle and into the carbon filter. Sample volatiles may be lost if the extraction needle assembly is inserted into the VOA headspace before connecting the tubing to the colorimetric tube.

Table 1 Troubleshooting Guide		
Problem	**Possible Cause**	**Solution**
Sample does not appear to be purging (bubbling) after the pump handle has been pulled.	Clogged/blocked purge (long) needle.	Use the decontamination syringe to check the purge needle for clogs. If clogged, clean the needle or use a new purge needle.
	Clogged/blocked extraction (short) needle.	Use decontamination syringe to check the extraction needle for clogs. Use decontamination syringe to clean the needle or use a new extraction needle.
	Colorimetric tube is not securely connected to hand pump.	Remove and re-insert the colorimetric tube from the hand pump. If the fit seems loose, replace the hand pump inlet gasket.
	Colorimetric tube is not securely connected to extraction needle tubing.	Check the connection between the extraction needle tubing and the colorimetric tube. If loose, insert the colorimetric tube further into the extraction needle tubing.
	VOA cap is not tightly sealed.	Check the tightness of the VOA cap. Tighten if necessary.
	Colorimetric tube tips were not broken before connecting to hand pump and tubing.	Break both tips of the colorimetric tube before connecting to hand pump and tubing.
	Broken/bad plunger seal in hand pump.	Check the pump seal by holding your finger over the hand pump inlet while pulling the pump handle and lock into the 50cc position. If no vacuum is apparent, open the pump, remove the plunger, replace the plunger seal, and grease the new seal. Re-assemble the pump.
The colorimetric tube shows no reaction after purging a sample that contains chlorinated compounds. (False Negative)	Colorimetric tube is below the optimum operating temperature.	Heat the colorimetric tube to 40°C/104° F before using. It is also recommended to heat the sample. The recommended temperature for tubes and samples when using the AQR Color-Tec® Method is 40°C/104° F.
	Colorimetric tube was connected using reversed flow direction.	Use the flow direction arrows to properly align the tube. The purged air must pass through the black oxidizer phase and the white catalyst phase before entering the yellow reagent phase.
	The sample also contains a detectable concentration of xylenes or toluene.	Samples can be tested for the presence of xylenes and toluene using the **Gastec 122L** colorimetric tube. The detection of chlorinated compounds may be diminished when xylenes or toluene are present in a sample.
The colorimetric tube indicates a reaction after purging a sample that contains no chlorinated compounds. (False Positive)	Chlorinated compounds are present at detectable concentrations the ambient air.	Test the ambient air using an LL tube to determine if chlorinated compounds are present at detectable concentrations. Attach the charcoal filter to the purge needle prior to purging samples.
	HCl vapor is present in the sample VOA or in the ambient air.	Avoid use of HCl in the area where AQR Color-Tec® is in use. Use only unpreserved VOAs for samples to be screened with AQR Color-Tec®.
	Water vapor has entered the yellow reagent phase of the tube indicating a positive reaction	NEVER purge more that 200 CCs through any sample. Stop purging before condensation inside the tube reaches the end of the black oxidizer phase. Avoid drawing any water from the sample VOA into the colorimetric tube.

5.0 Sample Purging and Detection Methodology

Samples may be purged using 50 cubic centimeters (cc), 100cc, or 200cc purge volumes. These various purge volumes are used in succession to maximize the low-level detection capability and detection range of each tube, thereby reducing the number of tubes needed to tentatively quantify the concentration of total chlorinated compounds in the sample. The pump stand is equipped with two VOA-vial holders to accommodate a second (duplicate) sample to be collected from each sampling location. This duplicate sample (collected and prepared in the same manner as the original sample) serves the following two potential purposes:

1. When purging the initial VOA vial does not induce a color change in the colorimetric tube, the second VOA vial containing the duplicate sample, may be purged (using the same colorimetric tube) to increase the probability of detecting very low (< 10 µg/L) concentrations.
2. When the initial test induces a color change that exceeds the upper limit of the LL tube (a tube reading > 3), the extra VOA vial can be used to analyze the sample using higher range colorimetric tubes (133L or 133M) to tentatively quantify the higher concentration of chlorinated compounds in the sample.

5.1 50cc Purge Volume

Initially, all samples are analyzed using a Gastec® 133-LL tube with a 50cc purge cycle. If the 50cc purge induces a color change reading of 1.5 to 3.0, read the calibration scale value aligned with the stained/unstained interface in the tube and use the pump stroke correction factors provided on the colorimetric tube instruction sheets to determine the correct reading for a 50cc purge volume. If the concentration in the sample exceeds the upper detection limit of the tube (i.e. the color change moves beyond the upper limit of the calibration scale printed on the tube), repeat the analysis using duplicate samples and higher range tubes (133-L and 133-M) until the color change reaction stops within the calibration scale on the tube. If the color change reaction exceeds the upper limit of the calibration scale of the M tube, the sample contains a concentration of chlorinated compounds above the upper detection capability of the AQR Color-Tec® Method.

5.2 100cc Purge Volume

Following completion of the 50cc purge cycle, if the concentration in the sample has induced a color change in the tube which traveled less than half the distance of the calibrated portion of the reagent phase of the tube (less than a reading of approximately 1.5), pull the pump handle outward and lock it into the 100cc position to complete a full purge cycle. Record the value aligned with the stained/unstained interface on the tube. No correction factor is needed for a 100cc purge.

5.3 200cc Purge Volume

Following completion of the 100cc purge cycle, if the concentration in the sample has induced no color change reaction, remove the purge needle and extraction needle assembly from the VOA vial containing the original sample and insert them into the VOA vial containing the duplicate sample (which has also been pre-heating) and perform another 100cc purge cycle **using the same colorimetric tube**. To perform the transfer to the second vial, remove both needles from the original VOA vial and immediately insert both needles into the septa of the duplicate sample VOA vial. Before re-inserting the pump handle, temporarily remove the colorimetric tube from the tip of the hand pump and re-insert the pump handle completely into the pump while the tube is un-attached. Re-attach the colorimetric tube into the pump tip and pull the pump handle and lock it into the 100cc position.

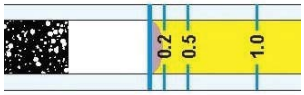
Read the calibration scale value aligned with the stained/unstained interface in the tube and use the pump stroke correction factors provided on Table 2 to determine the correct reading for a 200cc purge volume.

Table 2
Purge Volume Correction Factors for 133-Series Tubes

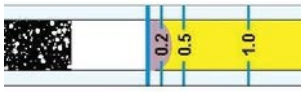
Colorimetric Tube	Purge Volume	Quantity of Pump Pulls	Correction Factor
133LL	50cc	½	Tube Reading x 3
133LL	100cc	1	Tube Reading x 1
133LL	200cc	2	Tube Reading ÷ 2
133L	50cc	½	Tube Reading x 3
133L	100cc	1	Tube Reading x 1
133L	200cc	2	Tube Reading ÷ 2
133M	50cc	½	Tube Reading x 2.5
133M	100cc	1	Tube Reading x 1
133M	200cc	2	Tube Reading ÷ 2.5

6.0 Reading the Tubes

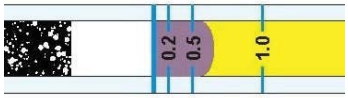
The basic AQR Color-Tec® method procedures are simple and intuitive; however, contaminant detection and semi-quantitative values are obtained through visual observation of the colorimetric reaction in the tubes, which is inherently subjective (especially in samples containing very low [<5 µg/L] total CVOHs). These low-level samples induce only a slight color change (i.e. slight darkening or light purple hue) prior to the 0.5ppm line on the tube scale at the entrance of yellow reagent layer in the LL tube. Samples containing concentrations of total chlorinated compounds above 5 µg/L usually induce a more apparent reaction within the LL tube.



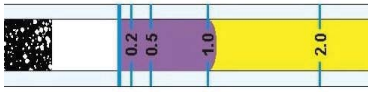
Positive Tube Result
Response Value = 0.1



Positive Tube Result
Response Value = 0.2



Positive Tube Result
Response Value = 0.6



Positive Tube Result
Response Value = 1.0

Positive Tube Result
Response Value = 2.0

6.1 Very Low Concentrations

When a sample contains very low concentrations (<10µg/L) of chlorinated compounds, the resulting color change is not immediate or distinct. At these low concentrations the color change does not usually begin until between 100 and 200 CCs of air have purged through the sample into the tube. Furthermore, the color change induced at these low concentrations is very slight (below 0.5 on the tube scale) and appears as a slight darkening or light purple hue at the entrance of yellow reagent layer in the LL tube.

6.2 Low to Medium Concentrations

When the sample contains higher concentrations (>10 µg/L) of chlorinated compounds, the resulting color change is an obvious light to dark purple, which propagates through the yellow reagent layer toward the pump end of the colorimetric tube. The detected concentration level is obtained by matching the linear extent of the discolored reagent inside the tube to the calibration scale printed on the outside of the tube.

6.3 High Concentrations

When the sample contains high concentrations (>100 µg/L) of chlorinated compounds, the color change reaction occurs quickly and usually exceeds the upper detection level of the Gastec® 133LL tube. The higher the concentration of chlorinated compounds in the sample, the faster the color change reaction occurs and the further it propagates through colorimetric tube. Samples containing percent-range concentrations (>1000 µg/L) of chlorinated compounds, often discolor the entire yellow reagent layer in the LL tube before the pump handle has been fully extended. In these cases, the purging can be discontinued to allow for the current sample bottle to be re-tested using a higher range detector tube. There is no need to continue purging the sample when the detection level of the tube is exceeded. Each subsequently higher range tube is used to purge each new duplicate sample in succession until the color change reaction does not exceed the calibration range of the tube being used.

6.4 Recording Tube Readings

It is recommended to record the observed concentration value (tube reading), the range of the colorimetric tube (LL, L, or M), and the final purge volume when logging AQR Color-Tec® results. For example, a reading of 2.5 observed on an LL tube using a 100 ml purge should be recorded as **2.5/LL/100**. Purge volume correction factors must be applied for AQR Color-Tec® values which were obtained using any purge volume other than 100cc. For example, a reading of 0.2 observed on an LL tube using a 200 ml purge should be recorded as **0.1/LL/200**. A reading of 60 observed on an M tube using a 50 ml purge should be recorded as **150/M/50.**

7.0 Estimating CVOH Concentrations from Tube Readings

The AQR Color-Tec® method is qualitative, but provides a general indication of the magnitude of the concentration present in a sample (i.e. low, medium, or high) based on the intensity/magnitude of the tube reaction (tube reading). AQR Color-Tec tube readings are used to estimate the concentration of CVOHs present in a water sample by comparing AQR Color-Tec® results to the results of split samples analyzed by GC/MS. Given a sufficient quantity of split sample pairs and sufficient range of concentration values, this comparison data can be used to obtain estimated concentrations for tube readings obtained from samples not selected for lab analysis.

7.1 Conversion Table

To provide a field-ready estimate of the total chlorinated solvent concentration in liquid and solid samples based on the colorimetric tube reading, AQR Color-Tec has developed a conversion table (see Table 3) based on statistical comparison water samples collected from chlorinated solvent sites in which the AQR Color-Tec and GC/MS methods were used to analyze split samples. The estimated concentration is obtained by matching the Color-Tec tube response to either the *median expected GC/MS concentration* or the *expected GC/MS concentration range* (see notes on Table 3 for definitions). Due to purging variables and the design of the colorimetric tubes, the potential range of corresponding analytical values associated with each positive tube reading is broad and increases significantly as the sample concentration increases. It should be emphasized that the analytical results presented on Table 3 are strictly estimates that represent the central tendency of the comparison data. Actual analytical values may differ substantially from this estimate and may fall outside of the corresponding ranges provided on Table 3.

The expected GC/MS concentrations presented in Table 3 are based on comparison of water sample data only. These conversion values may also be used for soil data; however, the potential range in expected GC/MS concentrations may be increased as a result of the difference in soil volumes used in the two methods and in the inherent heterogeneity of most soil matrices. However, the potential deviation factors included in the *expected GC/MS concentration range* column should be sufficient to account for the intrinsic analytical variability of most soil sample results.

Table 3

Conversion of AQR Color-Tec Responses to Total Chlorinated Volatile Organic Halocarbon Concentrations

AQR Color-Tec Tube Response (Tube Reading)	Median Expected GC/MS Concentration (liquid samples) (µg/L)	Range of Expected GC/MS Concentrations (liquid or solid samples) (µg/L or µg/kg)	
		Low	High
0	3	Below MDL	5
0.1	7	5	10
0.2	15	10	20
0.3	25	15	30
0.4	30	20	40
0.5	35	25	45
0.6	45	30	60
0.7	55	35	70
0.8	60	40	80
0.9	70	45	90
1	75	50	100
1.5	120	75	160
2	160	100	220
2.5	210	125	295
3	275	150	360
5	450	250	640
10	1,300	650	2,000
15	1,900	900	2,800
20	2,500	1,100	3,800
25	3,300	1,400	5,200
30	4,400	1,750	7,000
35	5,500	2,150	9,100
40	7,000	2,600	11,600
45	10,000	3,550	17,000
50	15,000	4,750	24,500
60	16,000	5,000	26,400
70	17,000	5,250	28,300
80	18,000	5,500	30,200
90	19,000	6,000	32,200
100	20,000	6,000	34,200
120	24,000	7,000	40,000
150	32,000	9,000	55,000
180	41,000	11,000	70,000
200	46,000	12,000	80,000
250	63,000	15,000	110,000
280	74,000	18,000	130,000
300	85,000	20,000	150,000

MDL = Analytical method detection limit

Notes:

The **Color-Tec Tube Response/Reading** (Color-Tec units) is the value printed on the colorimetric tube at the interface between the reacted and un-reacted reagent (the extent of the color change in the tube for a positive result).

The **Median Expected GC/MS Concentration** is the estimated concentration in micrograms per liter (µg/L) of total chlorinated volatile organic halocarbons (CVOHs) present in the sample for the corresponding Color-Tec tube response.

The **Expected GC/MS Concentration Range** is an estimated range of potential concentrations (µg/L or µg/kg) of total chlorinated volatile organic halocarbons (CVOHs) for the for the corresponding Color-Tec tube response.

The **Median Expected GC/MS Concentration** was obtained using statistical comparison of Color-Tec Method data and GC/MS (EPA Method 8260B) data. Comparison data were obtained from 5348 **water** samples collected from 152 chlorinated solvent (primarily PCE) sites in which the Color-Tec Method was used to analyze the samples in the field and either a laboratory based or mobile GC/MS was used to analyze split samples.

The **Expected GC/MS Concentration Range** reflects the potential deviation in the **Median Expected GC/MS Concentration** based on Color-Tec Method/EPA Method 8260B comparison results. The potential error increases as the concentration increases. The initial deviation factor used for a Color-Tec Reading of zero is +/- 30% and increases to +/- 400% at a Color-Tec Reading of 300 units.

The **Median Expected GC/MS Concentrations** presented in this table are based on comparison of water sample data only. These conversion values may also be used for soil data; however, the potential error or range in expected GC/MS concentrations may be increased as a result in the difference in soil volumes used in the two methods and in the inherent heterogeneity of many soil matrices. The potential deviation factors included in the **Expected GC/MS Concentration Range** data should be sufficient to account for the intrinsic analytical variability of most soil sample results.

The expected GC/MS concentrations in this table are provided only to give Color-Tec Method users an approximate concentration for the Color-Tec Tube Response. Actual GC/MS results on split samples may be outside of the stated range for a given Color-Tec Tube Response.

Refer to the **AQR Color-Tec Manual** for detailed information regarding general method principals and potential analytical variables.

8.0 QA/QC Procedures (For use with QA/QC Test Pack)

To insure that consistent results and the lowest possible detection levels are achieved for all samples analyzed using this method, standard sample preparation procedures tailored to specific project goals should be developed by the user and followed precisely and consistently throughout the sampling and analysis program.

This section of the manual describes procedures which are performed using the *AQR QA/QC Test Pack*, which provides the user with a basic methodology for conducting quality assurance/quality control (QA/QC) procedures for the AQR Color-Tec® method. Users of the method are encouraged to develop project-specific QA/QC and sample handling procedures that insure the level of consistency and accuracy required for the user's sampling program. This section presents some basic method-specific, QA/QC procedures developed to insure overall **method performance**, provide **analytical confidence**, identify potential **false positives** such as contaminants in the ambient air (since ambient air is used as the purge gas), and identify potential **false negatives** such as the presence chemical inhibitors that may be present in the samples or in the ambient air.

8.1 Method Performance and Analytical Confidence

Using the method to analyze 10ug/L, 50ug/L, and 100ug/L sample spikes will provide a comparison of AQR Color-Tec® readings to known concentrations, which provides a basis for estimating approximate concentrations in the field samples based on the AQR Color-Tec® responses. Testing of the higher range tubes using spiked samples is unnecessary because the high range tubes are usually not used unless the sample being tested has already exceeded the upper range of the low range tube, thus revealing that the sample being tested contains a sufficient quantity of chlorinated compounds to evoke a positive reaction from the next higher range tube.

8.2 False Negatives

The presence of Toluene and Xylenes inhibits/diminishes the ability of the colorimetric tubes to detect CVOHs. At sites where the presence of these compounds is suspected to be present in the samples or in the ambient air (since ambient air is used as the purge gas), QA procedures may include periodic testing of groundwater or soil samples and ambient air for the presence of toluene and xylenes using a Gastec® Toluene tube (the Toluene tube also detects xylenes).

8.3 False Positives

Because the AQR Color-Tec® method uses ambient air as the purge gas, airborne chlorinated compounds at low concentrations can enter the sample and activate the detector tube. To prevent airborne contaminants from entering the sample and detector tube during sample purging and analysis, the method is used with a carbon pre-filter attached to the purge needle. To determine whether airborne chlorinated contaminants are present, a colorimetric tube may used periodically to test the ambient air at the location where the field testing is being performed. It airborne contaminants are present and the carbon filter is being used, the carbon filters can also be tested periodically using a colorimetric tube to determine if breakthrough is occurring. A build-up of water vapor in the colorimetric tube past the catalyst stage (black portion of the tube) can induce a subtle color change similar to that of a low-level positive result. This problem is easily avoided by observing the build-up of condensation inside the tube in the catalyst stage during purging, and stopping the airflow before the condensation reaches the end of the catalyst stage. This condition rarely occurs before the maximum required purge volume of 200 CCs is achieved and contaminant presence or absence has been determined.

Contaminant Carryover

It is highly recommended that VOA vials and extraction needle assemblies be discarded following each test. Re-use of these expendable items may cause sufficient carryover of contaminants to cause a false positive result in subsequent samples.

8.4 Preparation of Spiked Samples for Method Performance QA/QC Tests

Spiked control samples are used to insure that the method is detecting the target compounds within reasonable limits and to provide a basis for estimating concentrations based on the AQR Color-Tec® responses. Sample spikes are prepared by combining the Cerilliant® TCE reference standards (provided in four 5 ml glass ampoules) with pre-measured, analyte-free water (provided in four VOA vials labeled with green [two vials], yellow, and red stickers on the caps). After transferring the reference standards from the ampoules to the four VOA vials, the vials will contain TCE concentrations of 10 µg/L (green label [two vials]), 50 µg/L (yellow label), and 100 µg/L (red label). To prepare your spiked samples for Color-Tec analysis, transfer each reference standard (in the glass ampoules) to each water-filled VOA as follows:

Reference Standard (Glass Ampoule)		Add the contents of each glass ampoule to each water-filled VOA	VOA Vial for Spike (pre-filled with water)	
Ampoule Label	**Concentration Before Dilution**		**Sticker Color**	**Concentration after Dilution**
TCE-60	60 µg/L	→	Green	10 µg/L
TCE-60	60 µg/L	→	Green	10 µg/L
TCE-300	300 µg/L	→	Yellow	50 µg/L
TCE-600	600 µg/L	→	Red	100 µg/L

Step 1 - Carefully break open one of the TCE-60 ampoules by grasping the body of the ampoule in one hand and the tip of the ampoule containing the plastic breaking collar in the other hand and apply bending pressure against the neck of the ampoule using your thumbs and index fingers. The tip of the ampoule should break along the scored restriction in the neck of the ampoule.

Step 2 - After breaking the ampoule, use a clean 10 ml pipette to carefully transfer all of the liquid from the ampoule into the VOA vial containing analyte-free water marked with the green label. Tightly re-seal the VOA cap and shake the sample for 5 seconds to mix. The first 10 µg/L spiked sample is now ready to pre-heat and test using the Color-Tec® method.

Prepare the second 10 µg/L spiked sample by repeating steps 1 and 2 using the second TCE-60 ampoule and the second VOA vial containing analyte-free water marked with a green label. Two 10 µg/L spikes are used because concentrations of 10 µg/L and below sometimes require the second 100cc purge (discussed in Sections 4.3 and 5.3) to see the color change.

To prepare the 50 µg/L spiked sample, repeat steps 1 and 2 using the TCE-300 ampoule and the VOA vial containing analyte-free water marked with a yellow label.

To prepare the 100 µg/L spiked sample, repeat steps 1 and 2 using the TCE-600 ampoule and the VOA vial containing analyte-free water marked with a red label.

The spiked samples are now ready to be analyzed using the AQR Color-Tec® method.

IMPORTANT NOTES: Be sure to transfer all of the liquid in the ampoule to the VOA vial and use care to prevent any spillage of the liquid from the VOA vial. Transfer the liquid as gently as possible and as quickly as possible to avoid loss of volatiles. The liquid in the ampoules and VOA vials have been precisely pre-measured to result in two 10 µg/L, one 50 µg/L, and one 100 µg/L sample spikes after mixing.

8.5 Method Performance QA/QC Test Procedure

The Color-Tec® readings obtained from testing the 10ug/L, 50ug/L, and 100ug/L sample spikes provides comparison to known concentrations to provide a basis for estimating approximate concentrations in the field samples based on the Color-Tec® responses. Following preparation of the 10 µg/L, 50 µg/L, and 100 µg/L sample spikes, heat the spiked samples and three 133LL tubes as described in section 8. After heating, conduct Color-Tec® analyses on the samples as described in Sections 3 and 4 and record the results in your field log as described in Section 5.3. A 200cc purge (as described in Section 4.3) may be required (using the second 10ug/L prepared spike) to produce a positive color-Tec reading when testing the 10 µg/L spiked samples. Any sample containing 10 µg/L or less of total CVOHs may require a 200cc purge (using two VOA vials) to produce a positive Color-Tec reading.

8.6 Negative Interference (Xylenes/Toluene) QA/QC Test Procedure

To conduct a test for the presence of compounds which could inhibit the detection of CVOHs use the Toluene (122L) tube to analyze a duplicate soil or water sample using the procedures described in Sections 2 through 4.

8.7 Positive Interference (Ambient Air) QA/QC Test Procedure

To conduct a test for the presence of chlorinated VOHs in the ambient air, break the tips of a 133LL colorimetric tube and properly insert it into the hand pump. Pull and lock the pump handle into the 100cc position allowing ambient air to enter the colorimetric tube. *Note: Do not attach an extraction needle assembly to the colorimetric tube while performing this test.* Once the 100cc flow cycle is completed, carefully read the tube and record the results. A positive result indicates the presence of CVOCs in the ambient air at concentrations detectable by AQR Color-Tec® which would affect sample results unless the carbon filter assembly is attached to the purge needle (see Section 9). A negative result indicates that CVOCs are not present in the ambient air at concentrations detectable by AQR Color-Tec® and therefore will not affect sample results. It is recommended that the carbon filter assembly is used regardless of the ambient air testing results.

8.8 Duplicate Sample Testing Procedure

Duplicate or replicate samples are collected from the same sampling location, at the same time, using the same collection methods, and analyzed using the same procedures as the original samples for the purpose of determining both sampling and analytical method variability. Since a second (duplicate) VOA vial is always collected for the Color-Tec® method, a duplicate or replicate analysis may be performed on the second (duplicate) VOA vial any time that a positive result (color change) is evoked by the original sample (first VOA vial) without exceeding the upper limit of the low-level colorimetric tube. In those cases, the duplicate or replicate analysis is simply performed by using a new low-level colorimetric tube to analyze the duplicate sample in the second (unused) VOA vial. If sampling and method variability is low, the result of the duplicate test will be the same or similar to the results obtained from the original test. The relative percent difference (RPD) may be calculated to quantify any variability in the results.

8.9 Collection of Split Samples for Laboratory Analysis

It is recommended that sample splits be collected for laboratory comparison analysis from 5 to 20 percent of the total quantity of samples analyzed using the AQR Color-Tec® method. Given a sufficient quantity of split sample pairs and sufficient range of concentration values, the GC/MS-to-AQR Color-Tec® comparison data may be used to obtain estimated concentrations for samples in the data set which were analyzed only using the AQR Color-Tec® method. This can be achieved using linear regression analysis of the comparison data. Statistical analysis of the comparison data can also be performed to determine site-specific AQR Color-Tec® method performance data.

9.0 Safety Precautions

As with the use of any product, it is recommended that the user carefully review all product manuals and Material Safety Data Sheets (MSDS) provided with this product prior to use. Several components of the AQR Color-Tec® kit are products obtained from other manufacturers which have manuals including safety precautions. Users of the AQR Color-Tec® method should carefully review the manuals and safety precautions and should become familiar with the proper use of all components included in the AQR Color-Tec® kit. It is recommended that the procedures involved with the method be incorporated into the user's Site-specific Safety and Health Plan (SSHP). MSDSs for all chemicals provided as part of the AQR Color-Tec® kit are available upon request. The following precautions should be considered to reduce potential user safety risks associated with the performance of the AQR Color-Tec® method.

Activity	Potential Risk	Precaution
Breaking tube tips	eye injury, dermal puncture	safety glasses
Accidental tube breakage	dermal cuts, exposure to reagent	safety gloves
Use of purge/extraction needles	dermal puncture	use caution
Use of the hot plate	dermal burns, electric shock	limited setting
Use of PCE standards	dermal contact, dermal cuts	safety gloves

Additional Safety Notes:

- Use skin and eye protection while breaking colorimetric and carbon filter tubes;
- The thermostat dial setting of the Corning® Hot Plate should never be set above 5 for any heating purposes required by the AQR Color-Tec method®;
- Do not over-fill the water bath pan while heating the samples and tubes;
- Always conduct sample and tube heating activities on a flat, stabile, surface.
- Keep all flammable or combustible materials away from the Corning® Hot Plate during sample and tube heating activities.
- Always use the stainless-steel water-bath pan properly filled with water for heating the samples and tubes – do not heat samples or tubes directly on the surface of the Corning® Hot Plate;
- Do not use any heat source to heat the water-bath, tubes, or samples other than the Corning® Hot Plate provided in the hardware kit.

Disposal of Expendable Materials:

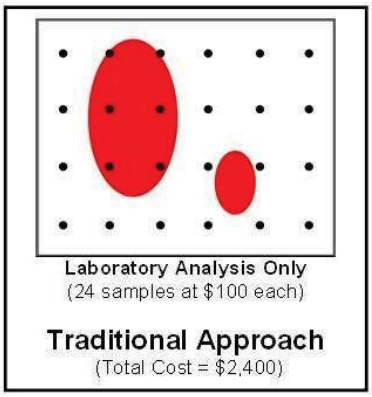
- Re-cap all needles before disposal;
- After re-capping each extraction needle, dispose of the extraction needle assembly while leaving the vinyl tubing attached to the colorimetric tube – Do not attempt to remove the extraction needle assembly from the tip of the colorimetric tube for disposal;
- Dispose of all sharps (needles and broken glassware) in accordance with any and all applicable local and/or federal rules or guidance.
- Dispose of all colorimetric tubes as specified in the Gastec® MSDS and/or in accordance with any and all applicable local and/or federal rules or guidance.
- Dispose of any remaining spiked-sample liquids as specified in the Cerilliant® MSDS and/or in accordance with any and all applicable local and/or federal rules or guidance.
- Dispose of all VOA vials used to contain sample materials in accordance with any and all applicable local and/or federal rules or guidance.

Product Warranty

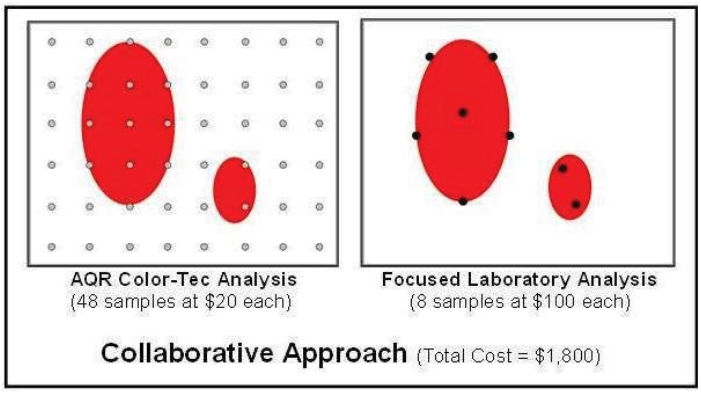
Air Quality Research warrants that the goods sold herein will be free from defects in material and workmanship. This warranty shall be limited to the replacement of defective parts. It is expressly agreed that this warranty shall be in lieu of all warranties of fitness and in lieu of the warrant of merchantability.

Source Area Identification at chlorinated solvent sites is highly complex given the low solubility of these compounds in water. Chlorinated solvent source zones often persist as suspended residual in unsaturated and saturated subsurface sediments for many decades. Surface water infiltration and groundwater flowing through the source zones slowly dissolves the suspended residual solvent leading to substantial aqueous phase contaminant plumes. Given the high volatility of most chlorinated compounds, residual solvents suspended in the unsaturated soil often leads to significant vapor phase contamination. The AQR Color-Tec® method is ideal for locating chlorinated solvent source areas by combining low level detection of all chlorinated compounds with low per sample cost to allow for significant expansion of sampling coverage compared to assessment approaches where only definitive analytical (laboratory) methods are employed to locate source areas. Definitive laboratory analysis provides high analytical accuracy, but sampling quantity is often limited to control costs, resulting in data gaps, sampling uncertainty, and low overall data quality. The low per-sample cost of AQR Color-Tec® method offers a 5:1 increase in analysis volume over laboratory methods, allowing for five times the sampling coverage for the same cost.

The illustrations below compare the traditional approach of source identification which uses only definitive laboratory analysis, to a collaborative approach which uses a high volume of AQR Color-Tec® data combined with a low quantity of definitive laboratory data. This collaborative approach combines high volume/low accuracy with low volume/high accuracy to achieve higher overall data quality than either method alone.



The diagram to the left shows the traditional site investigation scenario in which all samples collected are analyzed using only definitive analytical methods. The red areas represent previously unidentified source areas and black dots represent sampling locations intended to locate and delineate the contaminant plumes. Although this definitive-analysis only approach provides high analytical accuracy, the sampling quantity is often limited in order to control costs, resulting in data gaps, sampling uncertainty, and low overall data quality – and in this example the smaller source area remains undetected.



The two diagrams to the right show an investigation scenario in which a real-time measurement method, such as AQR Color-Tec®, is used to increase the overall sampling coverage, resulting in reduced sampling uncertainty and increased overall data quality. In this example, the smaller source area is identified and the AQR Color-Tec® data is verified and confirmed by focusing a reduced quantity of definitive, laboratory-based, analysis of split-samples onto the most critical areas of the site. Combining AQR Color-Tec® with focused laboratory analysis in this manner provides increased overall data quality and analytical accuracy at significantly lower costs than conventional approaches which rely only on definitive laboratory-based analysis.

Groundwater Profiling is the collection of discrete samples at multiple depths and locations working outward from known source areas to define the lateral and vertical extent of a dissolved groundwater contaminant plume. The technique is used in conjunction with the AQR Color-Tec® method at chlorinated solvent sites to allow for immediate decisions regarding subsequent vertical and lateral sampling locations.

Soil Matrix Profiling is similar to groundwater profiling, but uses sampling of the unsaturated soil to define the lateral and vertical extent of the vapor phase contamination.

Groundwater Matrix Profiling (Residual Zone Mapping) is similar to groundwater or soil profiling, but uses sampling of saturated unconsolidated aquifer matrix to define the lateral and vertical extent of suspended residual DNAPL.

Surface Water/Sediment/Pore Water Impact Evaluation is the collection and analysis of sediment, sediment pore water, and surface water to locate and characterize groundwater impacts on surface water.

Contact and Ordering Information

- **For more information visit www.aqrcolortec.com**
- **For kit orders contact Phil Pecevich at 919-918-7191**
  Email: pecevica@bellsouth.net
- **For technical support and training contact Perry Kelso at pkelso@aqrcolortec.com**

Equipment and Expendables

- **Hardware kit includes piston pump, pump stand, and heating equipment in a Pelican® hard case**
- **Expendables provided in 20-sample packs**
- **Expendables for QA/QC tests sold separately**
- **Cost per sample is $20**
- **Volume discounts available**
- **Professional technical support is included with every purchase**
- **Professional in-house or web-based training is available**

Hardware Kit

20-Sample Pack

QA/QC Pack

TETRA TECH NUS
FIELD TASK MODIFICATION REQUEST FORM

Project/Installation Name	CTO & Project Number	Task Mod. Number
Modification To (e.g. Work Plan)	Site/Sample Location	Date

Activity Description: _____

Reason for Change: _____

Recommended Disposition: _____

Field Operations Leader (Signature) _____ Date _____

Approved Disposition:

Project/Task Order Manager (Signature) _____ Date _____

Distribution:

Program/Project File –
Project/Task Order Manager –
Field Operations Leader –

Other: _____

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6.0 DEVIATIONS **7**

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to specify a consistent sample nomenclature system that will facilitate subsequent data management in a cost-effective manner. The sample nomenclature system has been devised such that the following objectives can be attained:

- Sorting of data by matrix
- Sorting of data by depth
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints (maximum of 20 characters)

2.0 SCOPE

The methods described in this SOP shall be used consistently for all projects requiring electronic data. Other contract- or project-specific sample nomenclature requirements may also be applicable.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

Program Manager - It shall be the responsibility of the Project Manager (or designee) to inform contract-specific Project Managers (PMs) of the existence and requirements of this SOP.

Project Manager - It shall be the responsibility of the PM to determine the applicability of this SOP based on: (1) program-specific requirements and (2) project size and objectives. It shall be the responsibility of the PM (or designee) to ensure that sample nomenclature requirements are thoroughly specified in the relevant project planning document (e.g., sampling and analysis plan) and are consistent with this SOP if relevant. It shall be the responsibility of the PM to ensure that the FOL is familiar with the sample nomenclature system.

Field Operations Leader (FOL) - It shall be the responsibility of the FOL to ensure that all field technicians or sampling personnel are thoroughly familiar with this SOP and the project-specific sample nomenclature system. It shall be the responsibility of the FOL to ensure that the sample nomenclature system is used during all project-specific sampling efforts.

General personnel qualifications for sample nomenclature activities in the field include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather) conditions.
- Familiarity with appropriate procedures for field documentation, handling, packaging, and shipping.

5.0 PROCEDURES

5.1 INTRODUCTION

The sample identification (ID) system can consist of as few as eight but not more than 20 distinct alpha-numeric characters. The sample ID will be provided to the laboratory on the sample labels and chain-of-custody forms. The basic sample ID provided to the laboratory has three segments and shall be as follows, where "A" indicates "alpha," and "N" indicates "numeric":

A or N 3 or 4 Characters	**AAA 2 or 3 Characters**	**A or N 3 to 6 Characters**
Site Identifier	Sample Type	Sample Location

Additional segments may be added as needed. For example:

(1) Soil and sediment sample ID

A or N 3 or 4 Characters	**AAA 2 or 3 Characters**	**A or N 3 to 6 Characters**	**NNNN 4 Characters**
Site identifier	Sample type	Sample location	Sample depth

(2) Aqueous (groundwater or surface water) sample ID

A or N 3 or 4 Characters	**AAA 2 or 3 Characters**	**A or N 3 to 6 Characters**	**NN 2 Characters**	**-A 1 Character**
Site identifier	Sample type	Sample location	Round number	Filtered sample only

(3) Biota sample ID

A or N 3 or 4 Characters	**AAA 2 or 3 Characters**	**A or N 3 to 6 Characters**	**AA 2 Characters**	**NNN 3 Characters**
Site identifier	Sample type	Sample location	Species identifier	Sample group number

5.2 SAMPLE IDENTIFICATION FIELD REQUIREMENTS

The various fields in the sample ID include but are not limited to the following:

- Site identifier
- Sample type
- Sample location
- Sample depth
- Sampling round number
- Filtered
- Species identifier
- Sample group number

The site identifier must be a three- or four-character field (numeric characters, alpha characters, or a mixture of alpha and numeric characters may be used). A site number is necessary because many

facilities/sites have multiple individual sites, Solid Waste Management Units (SWMUs), Operable Units (OUs), etc. Several examples are presented in Section 5.3 of this SOP.

The sample type must be a two- or three-character alpha field. Suggested codes are provided in Section 5.3 of this SOP.

The sample location must be at least a three-character field but may have up to six characters (alpha, numeric, or a mixture). The six characters may be useful in identifying a monitoring well to be sampled or describing a grid location.

The sample depth field is used to note the depth below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval in feet bgs of the sample. If the sample depth is equal to or greater than 100, then only the top interval would be represented and the sampling depth would be truncated to three characters. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet or boring log, in the logbook, etc.

A two-digit round number will be used to track the number of aqueous samples collected from a particular aqueous sample location. The first sample collected from a location will be assigned the round identifier 01, the second 02, etc. This applies to both existing and proposed monitoring wells and surface water locations.

Aqueous samples that are field filtered (dissolved analysis) will be identified with an "-F" in the last field segment. No entry in this segment signifies an unfiltered (total) sample.

The species identifier must be a two-character alpha field. Several suggested codes are provided in Section 5.3 of this SOP.

The three-digit sample group number will be used to track the number of biota sample groups (a particular group size may be determined by sample technique, media type, the number of individual caught, weight issues, time, etc.) by species and location. The first sample group of a particular species collected from a given location will be assigned the sample group number 001, and the second sample group of the same species collected from the same location will be assigned the sample group number 002.

5.3 EXAMPLE SAMPLE FIELD DESIGNATIONS

Examples of each of the fields are as follows:

Site identifier - Examples of site numbers/designations are as follows:

A01 - Area of Concern (AOC) 1
125 - SWMU 125
000 - Base- or facility-wide sample (e.g., upgradient well)
BBG - Base background

The examples cited are only suggestions. Each PM (or designee) must designate appropriate (and consistent) site designations for their individual project.

Sample type - Examples of sample types are as follows:

AH - Ash Sample
AS - Air Sample
BM - Building Material Sample

BSB - Biota Sample Full Body
BSF - Biota Sample Fillet
CP - Composite Sample
CS - Chip Sample
DS - Drum Sample
DU - Dust Sample
FP - Free Product
IDW - Investigation-Derived Waste Sample
LT - Leachate Sample
MW - Monitoring Well Groundwater Sample
OF - Outfall Sample
RW - Residential Well Sample
SB - Soil Boring Sample
SD - Sediment Sample
SC - Scrape Sample
SG - Soil Gas Sample
SL - Sludge Sample
SP - Seep Sample
SS - Surface Soil Sample
ST - Storm Sewer Water Sample
SW - Surface Water Sample
TP - Test Pit Sample
TW - Temporary Well Sample
WC - Well Construction Material Sample
WP - Wipe Sample
WS - Waste/Solid Sample
WW - Wastewater Sample

Sample location - Examples of the location field are as follows:

001 - Monitoring well 1
N32E92 - Grid location 32 North and 92 East
D096 - Investigation-derived waste drum number 96

Species identifier - Examples of species identifier are as follows:

BC - Blue Crab
GB - Blue Gill
CO - Corn
SB - Soybean

5.4 EXAMPLES OF SAMPLE NOMENCLATURE

The first round monitoring well groundwater sample collected from existing monitoring well 001 at SWMU 16 for a filtered sample would be designated as 016MW00101-F.

The second round monitoring well groundwater sample collected from existing monitoring well C20P2 at Site 23 for an unfiltered sample would be designated as 023MWC20P202.

The second surface water sample collected from point 01 at SWMU 130 for an unfiltered sample would be designated as 130SW00102.

A surface soil sample collected from grid location 32 North and 92 East at Site 32 at the 0- to 2-foot

interval would be designated as 032SSN32E920002.

A subsurface soil sample from soil boring 03 at SWMU 32 at an interval of 4 to 5 feet bgs would be designated as 032SB0030405.

A sediment sample collected at SWMU 19 from 0 to 6 inches at location 14 would be designated as 019SD0140001. The sample data sheet would reflect the precise depth at which this sample was collected.

During biota sampling for full-body analysis, the first time a minnow trap was checked at grid location A25 of SWMU 1415, three small blue gills were captured, collected, and designated with the sample ID of 1415BSBA25BG001. The second time blue gill were collected at the same location (grid location A25 at SWMU 1415), the sample ID would be 1415BSBA25BG002.

Note: No dash (-) or spacing is used between the segments with the exception of the filtered segment. The "F" used for a filtered aqueous sample is preceded by a dash (-F).

5.5 FIELD QA/QC SAMPLE NOMENCLATURE

Field Quality Assurance (QA)/Quality Control (QC) samples are designated using a different coding system. The QC code will consist of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

AA	NNNNNN	NN	-F
QC type	Date	Sequence number (per day)	Filtered (aqueous only, if needed)

The QC types are identified as:

TB = Trip Blank
RB = Rinsate Blank (Equipment Blank)
FD = Field Duplicate
AB = Ambient Conditions Blank
WB = Source Water Blank

The sampling time recorded on the chain-of-custody form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the routine sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory). Documentation for all other QC types (TB, RB, AB, and WB) will be recorded on the QC Sample Log Sheet (see SOP SA-6.3, Field Documentation).

5.6 EXAMPLES OF FIELD QA/QC SAMPLE NOMENCLATURE

The first duplicate of the day for a filtered groundwater sample collected on June 3, 2000, would be designated as FD06030001-F.

The third duplicate of the day taken of a subsurface soil sample collected on November 17, 2003, would be designated as FD11170303.

The first trip blank associated with samples collected on October 12, 2000, would be designated as TB10120001.

The only rinsate blank collected on November 17, 2001, would be designated as RB11170101.

6.0 DEVIATIONS

Any deviation from this SOP must be addressed in detail in the site-specific planning documents.

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A MIS REQUEST FORM **7**

1.0 PURPOSE

The purpose of this document is to specify a consistent procedure for the quality assurance review of electronic and hard copy databases. This SOP outlines the requirements for establishment of a Database Record File, Quality Assurance review procedures, and documentation of the Quality Assurance Review Process.

2.0 SCOPE

The methods described in this Standard Operating Procedure (SOP) shall be used consistently for all projects managed by Tetra Tech.

3.0 GLOSSARY

Chain-of-Custody Form - A Chain-of-Custody Form is a printed form that accompanies a sample or a group of samples from the time of sample collection to the laboratory. The Chain-of-Custody Form is retained with the samples during transfer of samples from one custodian to another. The Chain-of-Custody Form is a controlled document that becomes part of the permanent project file. Chain-of-Custody and field documentation requirements are addressed in SOP SA-6.1.

Electronic Database - A database provided on a compact laser disk (CD). Such electronic databases will generally be prepared using public domain software such as DBase, RBase, Oracle, Visual FoxPro, Microsoft Access, Paradox, etc.

Hardcopy Database - A printed copy of a database prepared using the software discussed under the definition of an electronic database.

Form I - A printed copy of the analytical results for each sample.

Sample Tracking Summary - A printed record of sample information including the date the samples were collected, the number of samples collected, the sample matrix, the laboratory to which the samples were shipped, the associated analytical requirements for the samples, the date the analytical data were received from the laboratory, and the date that validation of the sample data was completed.

4.0 RESPONSIBILITIES

Database Records Custodian - It shall be the responsibility of the Database Records Custodian to update and file the Sample Tracking Summaries for all active projects on a weekly basis. It shall be the responsibility of the Database Records Custodian to ensure that the most recent copies of the Sample Tracking Summaries are placed in the Database Records file. It shall be the responsibility of the Database Records Custodian to ensure that a copy of all validation deliverables is provided to the Project Manager (for placement in the project file). It shall be the responsibility of the Database Records Custodian to ensure that photocopies of all validation deliverables and historical data and reports (as applicable) are placed in the Database Records file.

Data Validation Coordinator - It shall be the responsibility of the Data Validation Coordinator (or designee) to ensure that the Sample Tracking Summaries are maintained by the Database Records Custodian. It shall be the responsibility of the Data Validation Coordinator (or designee) to ensure that photocopies of all data validation deliverables are placed in the applicable Database Records file by the Database Records Custodian.

Earth Sciences Department Manager - It shall be the responsibility of the Earth Sciences Department Manager (or equivalent) to ensure that all field personnel are familiar with the requirements of this Standard Operating Procedure (specifically Section 5.5).

FOL - It shall be the responsibility of the FOL (FOL) of each project to ensure that all field technicians or sampling personnel are thoroughly familiar with this SOP, specifically regarding provision of the Chain-of-Custody Forms to the Database Records Custodian. Other responsibilities of the FOL are described in Sections 5.4 and 5.5.

Management Information Systems (MIS) Manager - It shall be the responsibility of the MIS Manager to ensure that copies of original electronic deliverables (CDs) are placed in both the project files and the Database Records File. It shall be the responsibility of the MIS Manager (or designee) to verify the completeness of the database (presence of all samples) in both electronic and hardcopy form in the Database Records File. It shall be the responsibility of the MIS Manager to ensure that Quality Assurance Reviews are completed and are attested to by Quality Assurance Reviewers. It shall be the responsibility of the MIS Manager to ensure that records of the Quality Assurance review process are placed in the Database Records File. It shall be the responsibility of the MIS Manager to ensure that both electronic and hardcopy forms of the final database are placed in both the project and the Database Record File. It shall be the responsibility of the MIS Manager to ensure that data validation qualifiers are entered in the database.

Furthermore, it shall be the responsibility of the MIS Manager to participate in project planning at the request of the Project Manager, specifically with respect to the generation of level of effort and schedule estimates. To support the project planning effort, the MIS Manager shall provide a copy of the MIS Request From included as Attachment A to the project manager. It shall be the responsibility of the MIS Manager to generate level of effort and budget estimates at the time database support is requested if a budget does not exist at the time of the request. The MIS Request Form shall be provided to the Project Manager at the time of any such requests. It shall be the responsibility of the MIS Manager to notify the Project Manager of any anticipated level of effort overruns or schedule noncompliances as soon as such problems arise along with full justification for any deviations from the budget estimates (provided they were generated by the MIS Manager). It shall be the responsibility of the MIS Manager to document any changes to the scope of work dictated by the Project Manager, along with an estimate of the impact of the change on the level of effort and the schedule.

Program/Department Managers - It shall be the responsibility of the Department and/or Program Managers (or designees) to inform their respective department's Project Managers of the existence and requirements of this SOP.

Project Manager - It shall be the responsibility of each Project Manager to determine the applicability of this SOP based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the FOL is familiar with the requirements regarding Chain-of-Custody Form provision to the Database Records Custodian. It shall be the responsibility of the Project Manager (or designee) to determine which, if any, historical data are relevant and to ensure that such data (including all relevant information such as originating entity, sample locations, sampling dates, etc.) are provided to the Database Records Custodian for inclusion in the Database Records File. It shall be the responsibility of the Project Manager to obtain project planning input regarding the level of effort and schedule from the MIS Manager. It shall be the responsibility of the Project Manager to complete the database checklist (Attachment A) to support the level of effort and schedule estimate and to facilitate database preparation and subroutine execution.

Risk Assessment Department Manager - It shall be the responsibility of the Risk Assessment Department Manager to monitor compliance with this Standard Operating Procedure, to modify this SOP as necessary, and to take corrective action if necessary. Monitoring of the process shall be completed on a quarterly basis.

Quality Assurance Reviewers - It shall be the responsibility of the Quality Assurance Reviewers to verify the completeness of the sample results via review of the Chain-of-Custody Forms and Sample Tracking Summaries. It shall be the responsibility of the Quality Assurance Reviewers to ensure the correctness of the database via direct comparison of the hardcopy printout of the database and the hardcopy summaries of the original analytical data (e.g., Form Is provided in data validation deliverables). Correctness includes the presence of all relevant sample information (all sample information fields), agreement of the laboratory and database analytical results, and the presence of data validation qualifiers.

Quality Manager - It shall be the responsibility of the Quality Manager to monitor compliance with this Standard Operating Procedure via routine audits.

5.0 PROCEDURES

5.1 Introduction

Verification of the accuracy and completeness of an electronic database can only be accomplished via comparison of a hardcopy of the database with hardcopy of all relevant sample information. The primary purposes of this SOP are to ensure that 1) all necessary hardcopy information is readily available to Quality Assurance Reviewers; 2) ensure that the Quality Assurance review is completed in a consistent and comprehensive manner, and; 3) ensure that documentation of the Quality Assurance review process is maintained in the project file.

5.2 File Establishment

A Database Record file shall be established for a specific project at the discretion of the Project Manager. Initiation of the filing procedure will commence upon receipt of the first set of Chain-of-Custody documents from a FOL or sampling technician. The Database Record Custodian shall establish a project-specific file for placement in the Database Record File. Each file in the Database Record File shall consist of standard components placed in the file as the project progresses. Each file shall be clearly labeled with the project number, which shall be placed on the front of the file drawer and on each and every hanging file folder relevant to the project. The following constitute the minimum components of a completed file:

- Electronic Deliverables
- Sample Tracking Forms
- Chain-of-Custody Forms
- Data Validation Letters
- Quality Assurance Records

5.3 Electronic Deliverables

The format of electronic deliverables shall be specified in the laboratory procurement specification and shall be provided by the laboratory. The integrity of all original electronic data deliverables shall be maintained. This shall be accomplished via the generation of copies of each electronic deliverable provided by the laboratory. The original electronic deliverable shall be provided to the project manager for inclusion in the project file. A copy of the original electronic deliverable shall be placed in the Database Record File. The second copy shall be maintained by the MIS Manager (or designee) to be used as a working copy.

5.4 Sample Tracking Forms

Updated versions of the sample tracking form for each relevant project shall be maintained by the Database Record Custodian. The Sample Tracking Forms shall be updated any time additional Chain-of-Custody Forms are received from a FOL or sampling technician, or at any time that data are received from a laboratory, or at any time that validation of a given data package (sample delivery group) is completed. The Data Validation Coordinator shall inform the Database Record Custodian of the receipt of any data packages from the laboratory and of completion of validation of a given data package to facilitate updating of the Sample Tracking Form. The Database Record Custodian shall place a revised copy of the Sample Tracking Form in the Database Record File anytime it has been updated. Copies of the updated Sample Tracking Form shall also be provided to the project manager to apprise the project manager of sample package receipt, completion of validation, etc.

5.5 Chain-of-Custody Forms

The Chain-of-Custody Forms for all sampling efforts will be used as the basis for (1) updating the Sample Tracking Form, and (2) confirming that all required samples and associated analyses have been completed. It shall be the responsibility of the FOL (or sample technician) to provide a photocopy of all Chain-of-Custody Forms to the Database Record Custodian immediately upon completion of a sampling effort. The Database Record Custodian shall then place the copies of the Chain-of-Custody Form(s) in the Database Record File. Upon receipt of a sample data package from an analytical laboratory, the Data Validation Coordinator shall provide a copy of the laboratory Chain-of-Custody Form to the Database Record Custodian. The Database Record Custodian shall use this copy to update the Sample Tracking Summary and shall place the copy of the laboratory-provided Chain-of-Custody Form in the Database Record File. The photocopy of the laboratory-provided Chain-of Custody Form shall be stapled to the previously filed field copy. Upon receipt of all analytical data, two copies of the Chain-of-Custody will therefore be in the file. Review of the Chain-of-Custody Forms will therefore be a simple mechanism to determine if all data have been received. Chain-of-Custody is addressed in SOP SA-6.1.

5.6 Data Validation Letters

All data validation deliverables (or raw data summaries if validation is not conducted) shall be provided for inclusion in both the Database Record File and the project file. If USEPA regional- or client-specific requirements are such that Form Is (or similar analytical results) need not be provided with the validation deliverable, copies of such results must be appended to the deliverable. It is preferable, although not essential that the validation qualifiers be hand-written directly on the data summary forms. The data validation deliverables (and attendant analytical summaries) will provide the basis for direct comparison of the database printout and the raw data and qualifiers.

5.7 Historical Data

At the direction of the Project Manager, historical data may also be included in a project-specific analytical database. In the event that historical data are germane to the project, hardcopy of the historical data must be included in the Database Record File. Historical data may be maintained in the form of final reports or as raw data. The information contained in the historical data file must be sufficient to identify its origin, its collection date, the sample location, the matrix, and any and all other pertinent information. All available analytical data, Chain-of-Custody Forms, boring logs, well construction logs, sample location maps, shall be photocopied by the Project Manager (or designee) and placed in one or more 3-ring binders. All information shall be organized chronologically by matrix. It shall be the responsibility of the Project Manager (or designee) to ensure that all inconsistencies between analytical data, Chain-of-Custody Forms, boring logs, sample log sheets, and field logbooks are identified and corrected. The Project Manager (or designee) shall decide which nomenclature is appropriate and edit, initial and date all

relevant forms. Data entry may only be performed on information that has undergone the aforementioned editing process, thereby having a direct correlation between hardcopy information and what will become the electronic database.

6.0 RECORDS

Records regarding database preparation and quality assurance review include all those identified in the previous section. Upon completion of the database task, records from the file will be forwarded to the Project Manager for inclusion in the project file, or will be placed in bankers boxes (or equivalent) for storage. The final records for storage shall include the following minimum information on placards placed on both the top and end of the storage box:

Database Record File
PROJECT NUMBER: ____
SITE NAME: _____
DATE FILED: __/__/__
SUMMARY OF CONTENTS ENCLOSED
BOX _ OF _

Project- or program-specific record keeping requirements shall take precedence over the record keeping requirements of this SOP.

ATTACHMENT A

MIS REQUEST FORM

Project Name: _____ Request Date: _____
CTO: _____ Date Data Available for Production: _____
Project Manager: _____ Request in Support of: _____
Requestor: _____ Database Lead: _____
Program/Client: _____ GIS Lead: _____
State/EPA Region: _____ Statistics Lead: _____
Risk Lead: _____
Site Name(s) (Area, OU, etc.): _____
Sampling Date(s): _____
Matrix: ☐ GW ☐ SO ☐ SD ☐ SW ☐ Other: _____

Labels: ☐ Labels needed for an upcoming sampling event _____ Total # of Samples
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
_____ FOL
Additional Instructions: _____

Data Entry:
☐ Chemical data needs to be entered from hardcopy _____ Estimated # of Samples
☐ Chemical data needs to be formated electronically
☐ Field analytical data needs to be entered from hardcopy
☐ Geologic data needs to be entered from hardcopy
☐ Hydrology data needs to be entered from hardcopy
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

Tables:
☐ Full Data Printout
☐ Summary of Positive Hits
☐ Occurance and Distribution ☐ with criteria
☐ Sampling Analytical Summary
☐ Other: _____
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

GIS:
☐ General Facility Location
☐ Site Location
☐ Potentiometric Contours/Groundwater Flow
☐ Sample Location Proposed
☐ Sample Location Existing
☐ Tag Map Single Round
☐ Tag Map Multiple Round
☐ Isoconcentrations
☐ Chart Map
☐ 3D Visualization
☐ EGIS CD
☐ Other: _____
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

Statistics: ☐ Yes
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

Geostatistics: ☐ Yes
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

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A GENERALIZED POROSITY AND HYDRAULIC CONDUCTIVITY VALUES FOR GEOLOGIC MATERIALS 10

1.0 PURPOSE

This standard operating procedure (SOP) describes the process for developing contour maps and the approaches used to identify and quantify the direction and rate of groundwater flow and contaminant plume movement.

2.0 SCOPE

This document provides only a general overview of the field techniques, mathematical and physical relationships, and data handling procedures used for determining groundwater flow direction and rate. The references identified herein can provide a more complete explanation of particular methods and a more comprehensive discussion on the interpretation of hydrogeologic data.

3.0 GLOSSARY

Aquifer - A geologic formation capable of transmitting usable quantities of groundwater to a well or other discharge point.

Aquitard - A geologic formation that retards the flow of groundwater due to its low permeability.

Confined Aquifer - An aquifer that is overlain and underlain by zones of lower permeability (aquitards). If the aquifer is "artesian," the potentiometric head of the aquifer at a given point is higher than the top of the zone comprising the aquifer at that point.

Equipotential Line - A line connecting points of equal elevation of the water table or potentiometric surface. Equipotential lines on the water table are also called water table contour lines.

Flow Line - A flow line indicates the direction of groundwater movement within the saturated zone. Flow lines are drawn perpendicular to equipotential lines.

Flow Net - A diagram of groundwater flow showing flow lines and equipotential lines.

Hydraulic Conductivity (K) - A quantitative measure of the ability of porous material to transmit water. This is defined mathematically as the volume of water that will flow through a unit cross-sectional area of porous material per unit time under a head pressure gradient. Hydraulic conductivity is dependent on properties of the medium and fluid.

Hydraulic Gradient (i) - The rate of change of hydraulic head per unit distance of flow at a given point and in the downgradient direction.

Hydraulic Head - The height to which water will rise inside a well casing; equal to the elevation head plus the pressure head. In a well screened across the water table, hydraulic head equals the elevation head because the pressure head equals zero. In wells screened below the water table in an unconfined aquifer or screened at any interval within a confined aquifer, the head is the sum of the elevation of the aquifer (elevation head) and the fluid pressure of the water confined in the aquifer (pressure head).

North American Vertical Datum of 1988 (NAVD 88) - A common vertical control datum established in 1991 by the minimum-constraint adjustment of the Canadian-Mexican-U.S. leveling observations. It held fixed the height of the primary tidal benchmark, referenced to the new International Great Lakes Datum of 1985 local mean sea level height value, at Father Point/Rimouski, Quebec, Canada. Additional tidal benchmark elevations were not used due to the demonstrated variations in sea surface topography, i.e., the fact that mean sea level is not the same equipotential surface at all tidal benchmarks (Results of the

General Adjustment of the North American Datum of 1988, Surveying and Land Information Systems Vol. 52, No. 3, 1992 pp. 133-149).

Potentiometric (Piezometric) Surface - A hypothetical surface that coincides with the static level of the water in an aquifer (i.e., the maximum elevation to which water will rise in a well or piezometer penetrating the aquifer). The term "potentiometric surface" is usually applied to confined aquifers, although the water table is the potentiometric surface of an unconfined aquifer.

Unconfined Aquifer - An aquifer in which the water table forms the upper boundary.

Water Table - The surface in the groundwater system at which the fluid pressure is equal to atmospheric pressure (i.e., the net pressure head is zero) and below which all geologic strata are saturated with water.

4.0 RESPONSIBILITIES AND PERSONNAL REQUIREMENTS

Project Hydrogeologist - The project hydrogeologist has overall responsibility for obtaining water level measurements and developing groundwater contour maps. The hydrogeologist (with the concurrence of the Project Manager) will specify the reference point from which water levels are measured (usually a specific point on the upper edge of the inner well casing), the number of data points needed and which wells will be used for a contour map, and how many complete sets of water levels are required to adequately define groundwater flow directions (e.g., if there are seasonal variations).

Field Personnel - All supporting field personnel must have a basic familiarity with the equipment and procedures involved in obtaining water levels and must be aware of any project-specific requirements.

General personnel qualifications for contour map preparation include the following:

- Technical background in geosciences
- Familiarity with reading and interpreting boring logs and other geologic and hydrogeologic information

5.0 PROCEDURES

5.1 Potentiometric Surface Mapping

Construction of a potentiometric surface map includes the following general steps:

- Selecting wells
- Obtaining water level measurements and calculating groundwater elevations
- Constructing equipotential lines
- Determining groundwater flow direction(s)

Selecting Wells:

- All wells used to construct a single potentiometric map must represent the same hydrogeologic unit. The recorded water levels, monitoring well construction data, site geology, and topographic setting must be reviewed to ascertain that the wells are completed in the same hydrogeologic unit and to determine whether strong vertical hydraulic gradients may be present. Strong vertical hydraulic gradients will be manifested by a pronounced correlation between well depth and water level or by differences in water levels between two wells located near each other but having different screened intervals or screen lengths. Professional judgment of the hydrogeologist is important in this

determination. If vertical gradients are significant, the data to be used must be limited vertically, and only wells finished in a chosen vertical zone of the hydrogeologic unit can be used.

- At least three wells must be used to provide an estimation of the direction of groundwater flow, and the three wells should be distributed across the site in a configuration other than a straight line. Information from many more than three wells is generally needed to provide an accurate contour map. In general, shallow systems require data from more wells than deep systems for accurate contour mapping.

- Accurate and useful potentiometric surface maps for shallow flow systems require water level measurements from nearby surface water bodies, especially at sites where groundwater/surface water interactions are, or may be, important. Acquisition of these measurements should be incorporated into the field investigation planning process.

Obtaining Water Level Measurements and Calculating Groundwater Elevations

After selecting wells, the next step is to obtain water level measurements from the selected points. In addition, measurements from any other readily available wells/surface water bodies should be collected to ensure that sufficient data are available for interpretation purposes. To calculate groundwater elevations from water level measurements, survey data for all monitoring wells must be available and referenced to the same vertical datum. In addition, elevations of points and areas of groundwater discharge or recharge such as springs, seeps, streams, rivers, and lakes need to be determined, typically through staff gauge measurements.

***REMINDER*:**

All water level measurements to be used to generate potentiometric surface maps must be collected on the same day, preferably within 2 to 3 hours. This is especially important when working in an area where groundwater levels are tidally influenced or influenced by pumping.

Calculate groundwater elevations using water level measurements and elevation (survey) data as follows:

- Compile measurements of depth to water in the wells and surface water points to be used for mapping. Water level measurements in monitoring wells or piezometers are generally taken from the tops of the well casings (see SOP GH-1.2). It is important that the measurement points at all wells are documented (e.g., location of notch at top of PVC casing) so that the points at which measurements are taken can be surveyed. The procedure for surface water depth-to-water measurements depends on the location and nature of the point being used. For example, if a surface water measurement is required in an area with an accessible permanent feature that can be used for reference (e.g., a bridge), a measurement can be taken from a fixed point on the bridge, and the elevation of that point can later be surveyed.

- Compile surveyed elevations for the wells and surface water points, making sure that all elevations are referenced to the same vertical datum. If the difference in elevations across a site appears to be greater that the total change in elevation across the site, recheck the vertical datum. The North American Vertical Datum of 1988 (NAVD 88) is a common vertical datum, but site-specific datums are also used.

- Subtract the depth-to-water measurement at each well (generally in feet below top of casing) from the corresponding top-of-casing elevation (generally in feet above mean sea level referenced to NAVD 88) to calculate the groundwater (potentiometric surface) elevation at each well. For surface water

elevations, subtract the depth-to-water measurement to the surface water body from the elevation of the reference point at which the measurement was taken.

Constructing Equipotential Lines:

- Plot water level elevations on a site map. Other hydrogeologic features associated with the zone of interest, such as seeps, wetlands, and surface water bodies, should also be plotted along with their elevations.

- Contour the data using mathematically valid and generally accepted techniques. Linear interpolation is the most commonly used technique. However, quadratic interpolation or any technique of trend-surface analysis or data smoothing is acceptable. Computer-generated contour maps may be useful for rough mapping of large data sets; however, final detailed mapping must ***always*** be performed by hand by an experienced hydrogeologist. Draw all contours as smooth, continuous lines that never cross one another.

- Inspect the contour map, noting known features such as pumping wells and site topography, and adjust the contour lines using professional judgment in accordance with these features. Closed contours should be avoided unless a known groundwater sink (i.e., pumping well) or mound exists. Groundwater mounding is common under landfills and lagoons; if the data imply this, the feature must be evident in the contour plot.

- If the hydrogeologic system consists of a water table aquifer and one or more confined aquifers, prepare separate contour maps for each aquifer system. Develop water table maps using water level measurements from monitoring wells screened at the unsaturated-saturated interface. Contour water level measurements from monitoring wells screened in deeper portions of an unconfined aquifer as a separate potentiometric surface map(s). Contour surface water discharge or recharge features in the water table system.

- If constructing a vertical flow net, use a cross section aligned parallel to the direction of groundwater flow, and plot all water level measurements along this cross section, both deep and shallow, to develop equipotential lines and flow lines.

Determining Groundwater Flow Direction:

- Draw flow lines so that they are perpendicular to equipotential lines. Flow lines will begin at high head elevations and end at low head elevations. Closed highs will be the source of additional flow lines. Closed depressions (i.e., pumping wells) will be the termination of some flow lines. Care must be used in areas with significant vertical gradients to avoid erroneous conclusions concerning gradients and flow directions.

- Include a flow arrow(s) drawn perpendicular to the direction(s) of flow on each potentiometric surface contour map. The number of arrows required depends on the complexity of the flow system, but only major changes should have separate arrows. Again, professional judgment is required.

***REMINDER*:**

Have the completed cross section reviewed by another member of the geosciences group or another qualified person with similar experience.

5.2 Groundwater Flow Considerations

Groundwater movement is an integral part of the hydrologic cycle. Recharge to the shallow groundwater environment generally occurs by infiltration of precipitation through an upper unsaturated soil zone. Movement is downward under the force of gravity until the water reaches the saturated zone of the water table aquifer. After water has become part of the water table aquifer, movement is controlled by differences in hydraulic head, with movement from areas of high head to areas of low head. Areas of low head include natural discharge areas such as springs, lakes, rivers, and, ultimately, oceans. These features can be considered as outcrops of the water table. Points of low head also are created by pumping wells.

Local head differences and consequent vertical flow patterns within an aquifer can be detected by well clusters. A well cluster consists of several adjacent wells, generally installed within a few feet of each other, and screened at different depths. Variations in water levels in these closely spaced wells indicate the vertical component of groundwater flow within an aquifer, provided that the wells are all screened within the same aquifer.

The number, location, and extent of geologic units and their properties with regard to aquifer or aquitard characteristics must be understood to properly interpret water level data gathered from the monitoring system. This firm understanding of the hydrogeologic system must be developed through a program of borings, wells, and interpretation of subsurface geology. The adequacy of the positions and depths of borings/wells used to define relevant subsurface hydrogeologic conditions must also be assessed. The location of surface water discharge or recharge points must be considered. Surface water features influence the system because flow is most likely toward them (if they are discharge points) or away from them (if they are recharge points). Man-made discharge or recharge features such as pumping or injection wells, ditches, and trenches can also affect the flow of groundwater.

5.3 Determination of Flow Rate

Darcy's Law states that the quantity of water flowing through a geologic material is dependent on the permeability of the material, hydraulic gradient, and cross-sectional area through which the water flows. This relation is expressed in the equation:

$$Q = KiA$$

where:

Q	=	volume of water flowing through the cross sectional area of the formation (L^3/T)
K	=	hydraulic conductivity (L/T)
i	=	hydraulic gradient (L/L, i.e., dimensionless)
A	=	cross sectional area of formation being considered (L^2)

The relation is similar to one used in stream flow measurements where:

$$Q = VA$$

where:

Q	=	discharge from the cross sectional area of a stream or pipe (L^3/T)
V	=	average velocity of flowing water (L/T)
A	=	cross sectional area through which water flows (L^2)

To determine the velocity of water movement in a geologic formation, which depends on the specific formation properties and the head differences across the formation, use the following equation:

$$V = \frac{Ki}{n}$$

where:

V	=	average linear velocity of groundwater through the formation (L/T)
K	=	hydraulic conductivity (L/T)
i	=	hydraulic gradient (dimensionless)
n	=	porosity (expressed as a fraction)

Hydraulic conductivity, K, can be determined using slug tests (see SOP GH-2.4) packer tests (see SOP GH-2.2), pumping tests (see SOP GH-2.3), or geotechnical laboratory analysis of undisturbed soil samples (see SOP SA-1.3). Hydraulic conductivity is related to the permeability of the formation and depends on the size and interconnection of the pore spaces. In isotropic and homogeneous formations, the hydraulic conductivity will be the same vertically and horizontally. In anisotropic formations, horizontal and vertical conductivity can be markedly different, and the vertical hydraulic conductivity can be up to several orders of magnitude lower than the horizontal hydraulic conductivity. Typically, most formations are anisotropic with horizontal hydraulic conductivities at least several times greater than vertical hydraulic conductivities. Generally, hydraulic conductivities are high for sands, gravels, and limestone containing large solution cavities and low for silts, clays, and tightly fractured rock (see Attachment A).

Values of porosity, n, for several geologic materials are provided in Attachment A. More accurate and specific values of porosity can be obtained by laboratory analysis of site-specific formation samples or evaluation of unconfined aquifer pumping test results. Results from field testing usually provide greater (and more representative) hydraulic conductivities than laboratory testing because full-scale field testing includes the effects of the formational macrostructure (i.e., secondary permeability due to jointing or fractures), which is not reflected in the testing of a small sample in the laboratory.

Hydraulic gradient, i, is defined as the rate of change in hydraulic head (dh) per unit distance of flow (dl) determined from field measurements of hydraulic head, as follows:

- Using the potentiometric surface map generated as described above, measure the horizontal distance (generally in feet) between two equipotential lines (dl) that represent a significant portion of the site. If equipotential lines are spaced significantly differently in different areas of the site (e.g., closely spaced in the northern portion and widely separated in the southern portion), consider calculating separate gradients for the different sections of the site in addition to a site-wide gradient. The longer the distance over which the head change is measured, the more representative the gradient is of overall conditions. However, averaging gradients across large areas may not accurately represent the distribution of different gradients across the area.

- Do ***not*** measure from well to well; measure across equipotential lines that are drawn based on well (and other) hydraulic head data.

- Determine the change in head (dh) (generally in feet and in [or converted to] the same units as dl) between the equipotential lines described above (i.e, the difference in elevation between the lines). For example, if lines used in the horizontal distance measurement above represented 100 and 105 feet above mean sea level, the dh would be: 105 feet -100 feet = 5 feet.

- Using the values of dl and dh (in the same units) as determined above, calculate the hydraulic gradient by dividing the change in head by the length of the flow line using the following formula:

$$i = \frac{dh}{dl}$$

where:

dh = change in head (L)
dl = distance between equipotential lines (L)

- Because the distance and head differences (change in head) are in the same units, hydraulic gradients are dimensionless.

When chemical solutes are traveling in groundwater, as in cases of groundwater contamination, the calculated groundwater velocity may predict migration rates in excess of those actually observed. The difference in chemical versus water velocities may be due to attenuation or biodegradation of the chemical species in the aquifer. Attenuation is most often caused by adsorption of the chemical contaminant onto the formation grains or matrix. The result is that the chemical does not appear at the downgradient sampling point as quickly as the velocity calculation predicts. An equation to correct for this attenuation is:

$$V_c = V_w / (1 + K_d P_b / n)$$

where:

V_c = velocity of the chemical solute flow (L/T)
V_w = velocity of groundwater flow (L/T)
P_b = formation mass bulk density (M/L^3)
n = formation porosity (expressed as a fraction)
K_d = distribution coefficient = (L^3/M)

The K_d is equal to the mass of solute per unit mass of solid phase divided by the concentration of solute in a solution that is in equilibrium with the solid phase. The term in the denominator is known as the retardation factor.

Density and/or viscosity differences between water and contaminants can also cause velocity determination errors. Light hydrocarbons such as gasoline are less dense than water and consequently float on the water table. These contaminants can migrate along the water table surface at rates faster or slower than the rate of groundwater movement, depending on specific conditions, and may also volatilize into unsaturated soil pore spaces. Oils are more viscous than water and will typically migrate more slowly due to the viscosity difference. Contaminants denser than water such as heavy hydrocarbons (e.g., coal tar) or chlorinated compounds (e.g., TCE, PCE) tend to sink to the bottom of an aquifer if present in concentrations exceeding their solubility limit (these chemicals are often referred to as dense, nonaqueous phase liquids, or DNAPLs if present as a separate-phase liquid). Here, the contamination may move at faster or slower rates than the overlying groundwater or may actually move in a direction opposite to that of the groundwater, depending on the geologic characteristics of the aquifer base and direction of dip of the underlying aquitard.

Other factors involving the physicochemical interaction between the chemical and the groundwater, such as dilution (mixing contaminated water or chemicals with additional quantities of groundwater) and dispersion (molecular diffusion of the chemical throughout the groundwater regime), can also affect the observed rates of travel of contaminants in groundwater. In addition to such physicochemical characteristics, all of the aquifer and aquitard properties and groundwater flow characteristics described above must be known so that adequate and accurate estimations of the extent and rate of groundwater contaminant migration can be developed.

6.0 REFERENCES

Cedergren, H. R., 1977. Seepage, Drainage and Flow Nets (Second edition). John Wiley and Sons, New York.

Fetter, C. W., 1980. Applied Hydrogeology. Merrill, Columbus, Ohio, 488 pp.

Davis, S. N. and R. J. DeWiest, 1966. Hydrogeology. John Wiley and Sons, New York.

Freeze, R. A. and J. A. Cherry, 1979. Ground Water. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Johnson Division, UOP, Inc., 1975. Ground Water and Wells. Johnson Division, UOP, Inc., Saint Paul, Minnesota.

ATTACHMENT A

GENERALIZED POROSITY AND HYDRAULIC CONDUCTIVITY VALUES FOR GEOLOGIC MATERIALS

Material	Porosity Range (%)	Hydraulic Conductivity Range	
		cm/sec	ft/day
Gravel	30-40	10^{-1} to 10^{-2}	280 to 2.8 x 10^{5}
Coarse sand (clean)	30-40	10^{-1} to 1	280 to 2,800
Medium sand (clean)	35-45	10^{-2} to 10^{-1}	28 to 280
Fine sand (clean)	40-50	5 x 10^{-4} to 10^{-2}	1.4 to 28
Silty sand	25-40	10^{-5} to 10^{-2}	0.03 to 280
Glacial Till	Variable	10^{-10} to 10^{-4}	3 x 10^{-7} to 0.3
Unweathered Clay/Shale	45-55 (clay)	10^{-7} to 10^{-4}	3 x 10^{-4} to 0.3 (horizontal)
		10^{-10} to 10^{-6}	3 x 10^{-7} to 3 x 10^{-3} (vertical)
Karst Limestone	---	10^{-4} to 10^{-1}	0.3 to 2,800
Fractured Igneous/Metamorphic Rocks	---	10^{-6} to 10^{-1}	3 x 10^{-3} to 280
Sandstone	5-30	10^{-8} to 10^{-4}	3 x 10^{-5} to 0.3

Sources: Cedergren, 1977 and Fetter, 1980.

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1.0 PURPOSE

Utilities such as electric service lines, natural or propane gas lines, water and sewage lines, telecommunications, and steam lines are very often in the immediate vicinity of work locations. Contact with underground or overhead utilities can have serious consequences including employee injury/fatality, property and equipment damage, substantial financial impacts, and loss of utility service to users.

The purpose of this procedure is to provide minimum requirements and technical guidelines regarding the appropriate procedures to be followed when performing subsurface and overhead utility locating services. It is the policy of Tetra Tech NUS, Inc. (TtNUS) to provide a safe and healthful work environment for the protection of our employees. The purpose of this Standard Operating Procedure (SOP) is to aid in achieving the objectives of this policy, to present the acceptable procedures pertaining to utility locating and excavation clearance activities, and to present requirements and restrictions relevant to these types of activities. This SOP must be reviewed by any employee potentially involved with underground or overhead utility locating and avoidance activities.

2.0 SCOPE

This procedure applies to all TtNUS field activities where there may be potential contact with underground or overhead utilities. This procedure provides a description of the principles of operation, instrumentation, applicability, and implementability of typical methods used to determine the presence and avoidance of contact with utility services. This procedure is intended to assist with work planning and scheduling, resource planning, field implementation, and subcontractor procurement. Utility locating and excavation clearance requires site-specific information prior to the initiation of any such activities on a specific project. This SOP is not intended to provide a detailed description of methodology and instrument operation. Specialized expertise during both planning and execution of several of the methods presented may also be required.

3.0 GLOSSARY

Electromagnetic Induction (EMI) Survey - A geophysical exploration method whereby electromagnetic fields are induced in the ground and the resultant secondary electromagnetic fields are detected as a measure of ground conductivity.

Magnetometer – A device used for precise and sensitive measurements of magnetic fields.

Magnetic Survey – A geophysical survey method that depends on detection of magnetic anomalies caused by the presence of buried ferromagnetic objects.

Metal Detection – A geophysical survey method that is based on electromagnetic coupling caused by underground conductive objects.

Vertical Gradiometer – A magnetometer equipped with two sensors that are vertically separated by a fixed distance. It is best suited to map near surface features and is less susceptible to deep geologic features.

Ground Penetrating Radar – Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture.

4.0 RESPONSIBILITIES

Project Manager (PM)/Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this procedure.

Site Manager (SM)/Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Site Health & Safety Officer (SHSO) – Responsible to provide technical assistance and verify full compliance with this SOP. The SHSO is also responsible for reporting any deficiencies to the Corporate Health and Safety Manager (HSM) and to the PM/TOM.

Health & Safety Manager (HSM) – Responsible for preparing, implementing, and modifying corporate health and safety policy and this SOP.

Site Personnel – Responsible for performing their work activities in accordance with this SOP and the TtNUS Health and Safety Policy.

5.0 PROCEDURES

This procedure addresses the requirements and technical procedures that must be performed to minimize the potential for contact with underground and overhead utility services. These procedures are addressed individually from a buried and overhead standpoint.

5.1 Buried Utilities

Buried utilities present a heightened concern because their location is not typically obvious by visual observation, and it is common that their presence and/or location is unknown or incorrectly known on client properties. This procedure must be followed prior to beginning any subsurface probing or excavation that might potentially be in the vicinity of underground utility services. In addition, the Utility Clearance Form (Attachment 3) must be completed for every location or cluster of locations where intrusive activities will occur.

Where the positive identification and de-energizing of underground utilities cannot be obtained and confirmed using the following steps, the PM/TOM is responsible for arranging for the procurement of a qualified, experienced, utility locating subcontractor who will accomplish the utility location and demarcation duties specified herein.

1. A comprehensive review must be made of any available property maps, blue lines, or as-builts prior to site activities. Interviews with local personnel familiar with the area should be performed to provide additional information concerning the location of potential underground utilities. Information regarding utility locations shall be added to project maps upon completion of this exercise.

2., A visual site inspection must be performed to compare the site plan information to actual field conditions. Any findings must be documented and the site plan/maps revised. The area(s) of proposed excavation or other subsurface activities must be marked at the site in white paint or pin flags to identify those locations of the proposed intrusive activities. The site inspection should focus on locating surface indications of potential underground utilities. Items of interest include the presence of nearby area lights, telephone service, drainage grates, fire hydrants, electrical service vaults/panels, asphalt/concrete scares and patches, and topographical depressions. Note the location of any emergency shut off switches. Any additional information regarding utility

locations shall be added to project maps upon completion of this exercise and returned to the PM/TOM.

3. If the planned work is to be conducted on private property (e.g., military installations, manufacturing facilities, etc.) the FOL must identify and contact appropriate facility personnel (e.g., public works or facility engineering) before any intrusive work begins to inquire about (and comply with) property owner requirements. It is important to note that private property owners may require several days to several weeks advance notice prior to locating utilities.

4. If the work location is on public property, the state agency that performs utility clearances must be notified (see Attachment 1). State “one-call” services must be notified prior to commencing fieldwork per their requirements. Most one-call services require, by law, 48- to 72-hour advance notice prior to beginning any excavation. Such services typically assign a "ticket" number to the particular site. This ticket number must be recorded for future reference and is valid for a specific period of time, but may be extended by contacting the service again. The utility service will notify utility representatives who then mark their respective lines within the specified time frame. It should be noted that most military installations own their own utilities but may lease service and maintenance from area providers. Given this situation, “one call” systems may still be required to provide location services on military installations.

5. Utilities must be identified and their locations plainly marked using pin flags, spray paint, or other accepted means. The location of all utilities must be noted on a field sketch for future inclusion on project maps. Utility locations are to be identified using the following industry-standard color code scheme, unless the property owner or utility locator service uses a different color code:

white	excavation/subsurface investigation location
red	electrical
yellow	gas, oil, steam
orange	telephone, communications
blue	water, irrigation, slurry
green	sewer, drain

6. Where utility locations are not confirmed with a high degree of confidence through drawings, schematics, location services, etc., the work area must be thoroughly investigated prior to beginning the excavation. In these situations, utilities must be identified using safe and effective methods such as passive and intrusive surveys, or the use of non-conductive hand tools. Also, in situations where such hand tools are used, they should always be used in conjunction with suitable detection equipment, such as the items described in Section 6.0 of this SOP. Each method has advantages and disadvantages including complexity, applicability, and price. It also should be noted that in some states, initial excavation is required by hand to a specified depth.

7. At each location where trenching or excavating will occur using a backhoe or other heavy equipment, and where utility identifications and locations cannot be confirmed prior to groundbreaking, the soil must be probed using a device such as a tile probe which is made of non-conductive material such as fiberglass. If these efforts are not successful in clearing the excavation area of suspect utilities, hand shoveling must be performed for the perimeter of the intended excavation.

8. All utilities uncovered or undermined during excavation must be structurally supported to prevent potential damage. Unless necessary as an emergency corrective measure, TtNUS shall not make any repairs or modifications to existing utility lines without prior permission of the utility owner, property owner, and Corporate HSM. All repairs require that the line be locked-out/tagged-out prior to work.

5.2 Overhead Power Lines

If it is necessary to work within the minimum clearance distance of an overhead power line, the overhead line must be de-energized and grounded, or re-routed by the utility company or a registered electrician. If protective measures such as guarding, isolating, or insulating are provided, these precautions must be adequate to prevent employees from contacting such lines directly with any part of their body or indirectly though conductive materials, tools, or equipment.

The following table provides the required minimum clearances for working in proximity to overhead power lines.

Nominal Voltage	Minimum Clearance
0 -50 kV	10 feet, or one mast length; whichever is greater
50+ kV	10 feet plus 4 inches for every 10 kV over 50 kV or 1.5 mast lengths; whichever is greater

6.0 UNDERGROUND LOCATING TECHNIQUES

A variety of supplemental utility locating approaches are available and can be applied when additional assurance is needed. The selection of the appropriate method(s) to employ is site-specific and should be tailored to the anticipated conditions, site and project constraints, and personnel capabilities.

6.1 Geophysical Methods

Geophysical methods include electromagnetic induction, magnetics, and ground penetrating radar. Additional details concerning the design and implementation of electromagnetic induction, magnetics, and ground penetrating radar surveys can be found in one or more of the TtNUS SOPs included in the References (Section 8.0).

Electromagnetic Induction

Electromagnetic Induction (EMI) line locators operate either by locating a background signal or by locating a signal introduced into the utility line using a transmitter. A utility line acts like a radio antenna, producing electrons, which can be picked up with a radiofrequency receiver. Electrical current carrying conductors have a 60HZ signal associated with them. This signal occurs in all power lines regardless of voltage. Utilities in close proximity to power lines or used as grounds may also have a 60HZ signal, which can be picked up with an EM receiver. A typical example of this type of geophysical equipment is an EM-61.

EMI locators specifically designed for utility locating use a special signal that is either indirectly induced onto a utility line by placing the transmitter above the line or directly induced using an induction clamp. The clamp induces a signal on the specific utility and is the preferred method of tracing since there is little chance of the resulting signals being interfered with. A good example of this type of equipment is the Schonstedt® MAC-51B locator. The MAC-51B performs inductively traced surveys, simple magnetic locating, and traced nonmetallic surveys.

When access can be gained inside a conduit to be traced, a flexible insulated trace wire can be used. This is very useful for non-metallic conduits but is limited by the availability of gaining access inside the pipe.

Magnetics

Magnetic locators operate by detecting the relative amounts of buried ferrous metal. They are incapable of locating or identifying nonferrous utility lines but can be very useful for locating underground storage tanks (UST's), steel utility lines, and buried electrical lines. A typical example of this type of equipment is the Schonstedt® GA-52Cx locator. The GA-52Cx is capable of locating 4-inch steel pipe up to 8 feet deep.

Non-ferrous lines are often located by using a typical plumbing tool (snake) fed through the line. A signal is then introduced to the snake that is then traced.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture. In general, an object which is harder than the surrounding soil will reflect a stronger signal. Utilities, tunnels, UST's, and footings will reflect a stronger signal than the surrounding soil. Although this surface detection method may determine the location of a utility, this method does not specifically identify utilities (i.e., water vs. gas, electrical vs. telephone); hence, verification may be necessary using other methods. This method is somewhat limited when used in areas with clay soil types or with a high water table.

6.2 Passive Detection Surveys

Acoustic Surveys

Acoustic location methods are generally most applicable to waterlines or gas lines. A highly sensitive Acoustic Receiver listens for background sounds of water flowing (at joints, leaks, etc.) or to sounds introduced into the water main using a transducer. Acoustics may also be applicable to determine the location of plastic gas lines.

Thermal Imaging

Thermal (i.e., infrared) imaging is a passive method for detecting the heat emitted by an object. Electronics in the infrared camera convert subtle heat differentials into a visual image on the viewfinder or a monitor. The operator does not look for an exact temperature; rather they look for heat anomalies (either elevated or suppressed temperatures) characteristic of a potential utility line.

The thermal fingerprint of underground utilities results from differences in temperature between the atmosphere and the fluid present in a pipe or the heat generated by electrical resistance. In addition, infrared scanners may be capable of detecting differences in the compaction, temperature and moisture content of underground utility trenches. High-performance thermal imagery can detect temperature differences to hundredths of a degree.

6.3 Intrusive Detection Surveys

Vacuum Excavation

Vacuum excavation is used to physically expose utility services. The process involves removing the surface material over approximately a 1' x 1' area at the site location. The air-vacuum process proceeds with the simultaneous action of compressed air-jets to loosen soil and vacuum extraction of the resulting

debris. This process ensures the integrity of the utility line during the excavation process, as no hammers, blades, or heavy mechanical equipment comes into contact with the utility line, eliminating the risk of damage to utilities. The process continues until the utility is uncovered. Vacuum excavation can be used at the proposed site location to excavate below the "utility window" which is usually 8 feet.

Hand Excavation

When the identification and location of underground utilities cannot be positively confirmed through document reviews and/or other methods, borings and excavations may be cleared via the use of non-conductive hand tools. This should always be done in conjunction with the use of detection equipment. This would be required for all locations where there is a potential to impact buried utilities. The minimum hand-excavation depth that must be reached is to be determined considering the geographical location of the work site. This approach recognizes that the placement of buried utilities is influenced by frost line depths that vary by geographical region. Attachment 2 presents frost line depths for the regions of the contiguous United States. At a minimum, hand excavation depths must be at least to the frost line depth (see Attachment 2) plus two (2) feet, but never less than 4 feet below ground surface (bgs). For hand excavation, the hole created must be reamed large enough to be at least the diameter of the drill rig auger or bit prior to drilling. For soil gas surveys, the survey probe shall be placed as close as possible to the cleared hand excavation. It is important to note that a post-hole digger must not be used in this type of hand excavation activity.

Tile Probe Surveys

For some soil types, site conditions, and excavation requirements, non-conductive tile probes may be used. A tile probe is a “T”-handled rod of varying lengths that can be pushed into the soil to determine if any obstructions exist at that location. Tile probes constructed of fiberglass or other nonconductive material are readily-available from numerous vendors. Tile probes must be performed to the same depth requirements as previously specified. As with other types of hand excavating activities, the use of a non-conductive tile probe, should always be in conjunction with suitable utility locating detection equipment.

7.0 INTRUSIVE ACTIVITIES SUMMARY

The following list summarizes the activities that must be performed prior to beginning subsurface activities:

1. Map and mark all subsurface locations and excavation boundaries using white paint or markers specified by the client or property owner.

2. Notify the property owner and/or client that the locations are marked. At this point, drawings of locations or excavation boundaries shall be provided to the property owner and/or client so they may initiate (if applicable) utility clearance.

   Note: Drawings with confirmed locations should be provided to the property owner and/or client as soon as possible to reduce potential time delays.

3. Notify “One Call” service. If possible, arrange for an appointment to show the One Call representative the surface locations or excavation boundaries in person. This will provide a better location designation to the utilities they represent. You should have additional drawings should you need to provide plot plans to the One Call service.

4. Implement supplemental utility detection techniques as necessary and appropriate to conform utility locations or the absence thereof.

5. Complete Attachment 3, Utility Clearance Form. This form should be completed for each excavation location. In situations where multiple subsurface locations exist within the close proximity of one another, one form may be used for multiple locations provided those locations are noted on the Utility Clearance Form. Upon completion, the Utility Clearance Form and revised/annotated utility location map becomes part of the project file.

8.0 REFERENCES

OSHA Letter of Interpretation, Mr. Joseph Caldwell, Attachment 4
OSHA 29 CFR 1926(b)(2)
OSHA 29 CFR 1926(b)(3)
Tt Utility Locating and Clearance Policy
Tt SOP GH-3.1; Resistivity and Electromagnetic Induction
Tt SOP GH-3.2; Magnetic and Metal Detection Surveys
Tt SOP GH-3.4; Ground-penetrating Radar Surveys

ATTACHMENT 1
LISTING OF UNDERGROUND UTILITY CLEARANCE RESOURCES

American Public Works Association
2345 Grand Boulevard, Suite 500, Kansas City, MO 64108-2625
Phone (816) 472-6100 • Fax (816) 472-1610
Web www.apwa.net • E-mail apwa@apwa.net

ONE-CALL SYSTEMS INTERNATIONAL CONDENSED DIRECTORY

Alabama
Alabama One-Call
1-800-292-8525

Alaska
Locate Call Center of Alaska, Inc.
1-800-478-3121

Arizona
Arizona Blue Stake
1-800-782-5348

Arkansas
Arkansas One Call System, Inc.
1-800-482-8998

California
Underground Service Alert North
1-800-227-2600
Underground Service Alert of Southern California
1-800-227-2600

Colorado
Utility Notification Center of Colorado
1-800-922-1987

Connecticut
Call Before You Dig
1-800-922-4455

Delaware
Miss Utility of Delmarva
1-800-282-8555

Florida
Sunshine State One-Call of Florida, Inc.
1-800-432-4770

Georgia
Underground Protection Center, Inc.
1-800-282-7411

Hawaii
Underground Service Alert North
1-800-227-2600

Idaho
Dig Line Inc.
1-800-342-1585
Kootenal County One-Call
1-800-428-4950
Shoshone - Benewah One-Call
1-800-398-3285

Illinois
JULIE, Inc.
1-800-892-0123
Digger (Chicago Utility Alert Network)
312-744-7000

Indiana
Indiana Underground Plant Protection Service
1-800-382-5544

Iowa
Iowa One-Call
1-800-292-8989

Kansas
Kansas One-Call System, Inc.
1-800-344-7233

Kentucky
Kentucky Underground Protection Inc.
1-800-752-6007

Louisiana
Louisiana One Call System, Inc.
1-800-272-3020

Maine
Dig Safe System, Inc.
1-888-344-7233

Maryland
Miss Utility
1-800-257-7777
Miss Utility of Delmarva
1-800-282-8555

Massachusetts
Dig Safe System, Inc.
1-888-344-7233

Michigan
Miss Dig System, Inc.
1-800-482-7171

Minnesota
Gopher State One Call
1-800-252-1166

Mississippi
Mississippi One-Call System, Inc
1-800-227-6477

Missouri
Missouri One-Call System, Inc.
1-800-344-7483

Montana
Utilities Underground Protection Center
1-800-424-5555
Montana One Call Center
1-800-551-8344

Nebraska
Diggers Hotline of Nebraska
1-800-331-5666

Nevada
Underground Service Alert North
1-800-227-2600

New Hampshire
Dig Safe System, Inc.
1-888-344-7233

New Jersey
New Jersey One Call
1-800-272-1000

New Mexico
New Mexico One Call System, Inc.
1-800-321-2537
Las Cruces- Dona Ana Blue Stakes
1-888-526-0400

New York
Dig Safely New York
1-800-962-7962
New York City- Long Island One Call Center
1-800-272-4480

North Carolina
The North Carolina One-Call Center, Inc.
1-800-632-4949

North Dakota
North Dakota One-Call
1-800-795-0555

Ohio
Ohio Utilities Protection Service
1-800-362-2764
Oil & Gas Producers Underground Protect'n Svc
1-800-925-0988

Oklahoma
Call Okie
1-800-522-6543

Oregon
Oregon Utility Notification Center/One Call Concepts
1-800-332-2344

Pennsylvania
Pennsylvania One Call System, Inc.
1-800-242-1776

Rhode Island
Dig Safe System, Inc.
1-888-344-7233

South Carolina
Palmetto Utility Protection Service Inc.
1-888-721-7877

South Dakota
South Dakota One Call
1-800-781-7474

Tennessee
Tennessee One-Call System, Inc.
1-800-351-1111

ATTACHMENT 1 (Continued)

Texas
Texas One Call System
1-800-245-4545
Texas Excavation Safety System, Inc.
1-800-344-8377
Lone Star Notification Center
1-800-669-8344

Utah
Blue Stakes of Utah
1-800-662-4111

Vermont
Dig Safe System, Inc.
1-888-344-7233

Virginia
Miss Utility of Virginia
1-800-552-7001
Miss Utility (Northern Virginia)
1-800-257-7777

Washington
Utilities Underground Location Center
1-800-424-5555
Northwest Utility Notification Center
1-800-553-4344
Inland Empire Utility Coordinating Council
509-456-8000

West Virginia
Miss Utility of West Virginia, Inc.
1-800-245-4848

Wisconsin
Diggers Hotline, Inc.
1-800-242-8511

Wyoming
Wyoming One-Call System, Inc.
1-800-348-1030
Call Before You Dig of Wyoming
1-800-849-2476

District of Columbia
Miss Utility
1-800-257-7777

Alberta
Alberta One-Call Corporation
1-800-242-3447

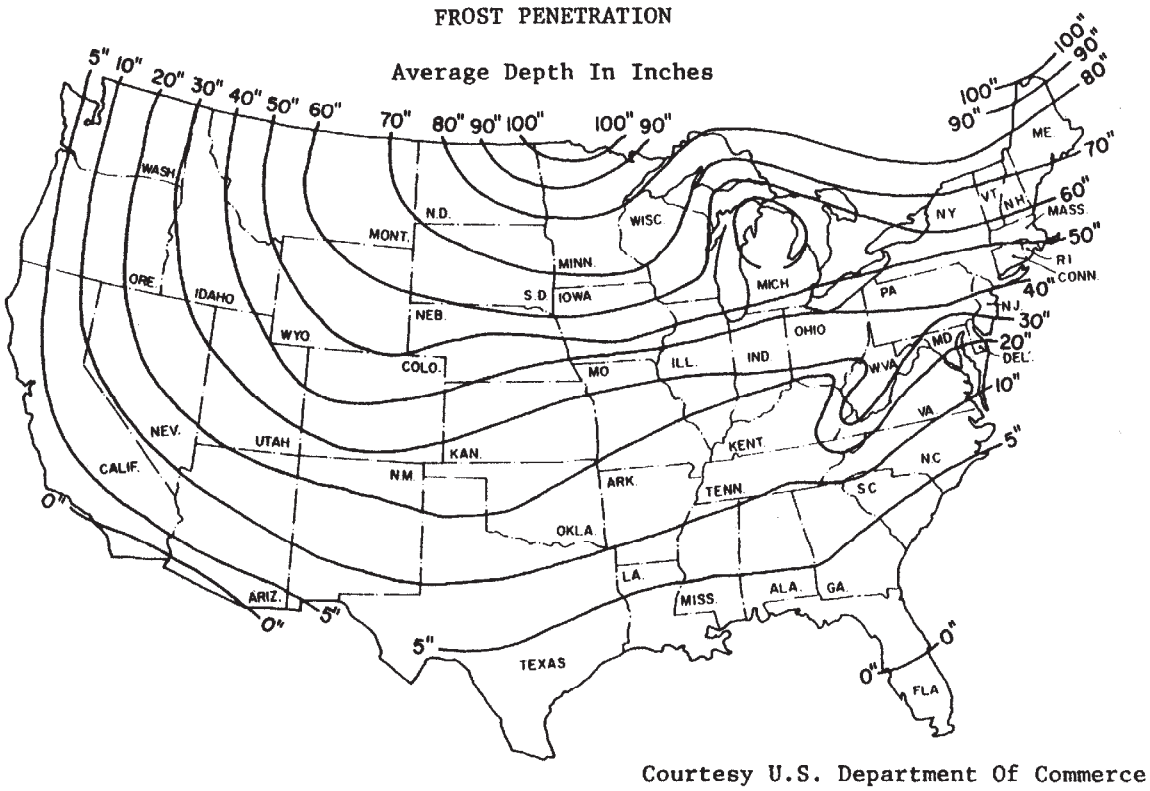
British Columbia
BC One Call
1-800-474-6886

Ontario
Ontario One-Call System
1-800-400-2255

Quebec
Info-Excavation
1-800-663-9228

ATTACHMENT 2

FROST LINE PENETRATION DEPTHS BY GEOGRAPHIC LOCATION



ATTACHMENT 3
UTILITY CLEARANCE FORM

Client: _____ Project Name: _____

Project No.: _____ Completed By: _____

Location Name: _____ Work Date: _____

Excavation Method/Overhead Equipment:_____

1. Underground Utilities — Circle One

a)	Review of existing maps?	yes no N/A
b)	Interview local personnel?	yes no N/A
c)	Site visit and inspection?	yes no N/A
d)	Excavation areas marked in the field?	yes no N/A
e)	Utilities located in the field?	yes no N/A
f)	Located utilities marked/added to site maps?	yes no N/A
g)	Client contact notified Name _____ Telephone: _____ Date: _____	yes no N/A
g)	State One-Call agency called? Caller: _____ Ticket Number: _____ Date: _____	yes no N/A
h)	Geophysical survey performed? Survey performed by:_____ Method: _____ Date: _____	yes no N/A
i)	Hand excavation performed (with concurrent use of utility detection device)? Completed by:_____ Total depth:_____feet Date: _____	yes no N/A
j)	Trench/excavation probed? Probing completed by:_____ Depth/frequency: _____ Date: _____	yes no N/A

2. Overhead Utilities — Present Absent

a)	Determination of nominal voltage	yes no N/A
b)	Marked on site maps	yes no N/A
c)	Necessary to lockout/insulate/re-route	yes no N/A
d)	Document procedures used to lockout/insulate/re-route	yes no N/A
e)	Minimum acceptable clearance (SOP Section 5.2): _____	

3. Notes:

_____

_____

_____

Approval:

_____ _____

Site Manager/Field Operations Leader Date

c: PM/Project File
Program File

ATTACHMENT 4
OSHA LETTER OF INTERPRETATION

Mr. Joseph Caldwell
Consultant
Governmental Liaison
Pipeline Safety Regulations
211 Wilson Boulevard
Suite 700
Arlington, Virginia 22201

Re: Use of hydro-vacuum or non-conductive hand tools to locate underground utilities.

Dear Mr. Caldwell:

In a letter dated July 7, 2003, we responded to your inquiry of September 18, 2002, regarding the use of hydro-vacuum equipment to locate underground utilities by excavation. After our letter to you was posted on the OSHA website, we received numerous inquiries that make it apparent that aspects of our July 7 letter are being misunderstood. In addition, a number of industry stakeholders, including the National Utility Contractors Association (NUCA), have provided new information regarding equipment that is available for this work.

To clarify these issues, we are withdrawing our July 7 letter and issuing this replacement response to your inquiry.

Question: *Section 1926.651 contains several requirements that relate to the safety of employees engaged in excavation work. Specifically, paragraphs (b)(2) and (b)(3) relate in part to the safety of the means used to locate underground utility installations that, if damaged during an uncovering operation, could pose serious hazards to employees.*

Under these provisions, what constitutes an acceptable method of uncovering underground utility lines, and further, would the use of hydro-vacuum excavation be acceptable under the standard?

Answer

Background

Two sections of 29 CFR 1926 Subpart P (Excavations), 1926.651(Specific excavation requirements), govern methods for uncovering underground utility installations. Specifically, paragraph (b)(2) states:

> When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours * * * or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used. (emphasis added).

Paragraph (b)(3) provides:

ATTACHMENT 4 (Continued)

> When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means. (emphasis added).

Therefore, "acceptable means" must be used where the location of the underground utilities have not been identified by the utility companies and detection equipment is not used.

Subpart P does not contain a definition of either "other acceptable means" or "safe and acceptable means." The preambles to both the proposed rule and the final rule discussed the rationale behind the wording at issue. For example, the preamble to the proposed rule, 52 Fed. Reg. 12301 (April 15, 1987), noted that a 1972 version of this standard contained language that specified "careful probing or hand digging" as the means to uncover utilities. The preamble then noted that an amendment to the 1972 standard later deleted that language "to allow other, *equally effective means* of locating such installations." The preamble continued that in the 1987 proposed rule, OSHA again proposed using language in section (b)(3) that would provide another example of an acceptable method of uncovering utilities that could be used *where the utilities have not been marked and detection equipment is not being used* – "probing with hand-held tools." This method was rejected in the final version of 29 CFR 1926. As OSHA explained in the preamble to the final rule, 54 Fed. Reg. 45916 (October 31, 1989):

> OSHA received two comments * * * and input from ACCSH [OSHA's Advisory Committee on Construction Safety and Health] * * * on this provision. All commenters recommended dropping 'such as probing with hand-held tools' from the proposed provision, because this could create a hazard to employees by damaging the installation or its insulation.

In other words, the commenters objected to the use of hand tools being used unless detection equipment was used in conjunction with them. OSHA then concluded its discussion relative to this provision by agreeing with the commentators and ultimately not including any examples of "acceptable means" in the final provision.

Non-conductive hand tools are permitted

This raises the question of whether the standard permits the use of hand tools alone -- without also using detection equipment. NUCA and other industry stakeholders have recently informed us that non-conductive hand tools that are appropriate to be used to locate underground utilities are now commonly available.

Such tools, such as a "shooter" (which has a non-conductive handle and a snub nose) and non-conductive or insulated probes were not discussed in the rulemaking. Since they were not considered at that time, they were not part of the class of equipment that was thought to be unsafe for this purpose. Therefore, we conclude that the use of these types of hand tools, when used with appropriate caution, is an "acceptable means" for locating underground utilities.

ATTACHMENT 4 (Continued)

Hydro-vacuum excavation

It is our understanding that some hydro-vacuum excavation equipment can be adjusted to use a minimum amount of water and suction pressure. When appropriately adjusted so that the equipment will not damage underground utilities (especially utilities that are particularly vulnerable to damage, such as electrical lines), use of such equipment would be considered a "acceptable means" of locating underground utilities. However, if the equipment cannot be sufficiently adjusted, then this method would not be acceptable under the standard.

Other technologies

We are not suggesting that these are the only devices that would be "acceptable means" under the standard. Industry stakeholders have informed us that there are other types of special excavation equipment designed for safely locating utilities as well.

We apologize for any confusion our July 7 letter may have caused. If you have further concerns or questions, please feel free to contact us again by fax at: U.S. Department of Labor, OSHA, Directorate of Construction, Office of Construction Standards and Compliance Assistance, fax # 202-693-1689. You can also contact us by mail at the above office, Room N3468, 200 Constitution Avenue, N.W., Washington, D.C. 20210, although there will be a delay in our receiving correspondence by mail.

Sincerely,

Russell B. Swanson, Director
Directorate of Construction

NOTE: OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA=s interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov.

TETRA TECH	STANDARD OPERATING PROCEDURES	Number SA-1.6	Page 1 of 21
		Effective Date 01/2012	Revision 2
		Applicability Tetra Tech, Inc.	
		Prepared Earth Sciences Department	
Subject NATURAL ATTENUATION PARAMETER COLLECTION		Approved J. Zimmerly	

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1.0 PURPOSE

The purpose of this document is to provide general reference information regarding natural attenuation parameter and methodology selection, sample collection, and a general understanding of the sample results.

2.0 SCOPE

This document provides information on selection of appropriate groundwater natural attenuation parameters, selection of sampling methods for these parameters, techniques for onsite field analysis of select parameters, and some basic understanding of the field sample results. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling practices and techniques. To a limited extent, it shall also facilitate the understanding and interpretation of the sampling results. It addresses field procedures for collection of data at sites with organic groundwater contaminants (e.g., chlorinated and petroleum hydrocarbons) to the extent practical. The focus of this document is on natural attenuation, not enhanced bioremediation.

The techniques described shall be followed whenever applicable, noting that site-specific conditions, project-specific objectives, local, state, and federal guidelines may be used as a basis for modification of the procedures noted herein. The intent of this document is to supplement the local, state, and federal guidance documents and manufacturer's analytical methods referenced in Section 6.0. It is not intended for this document to supersede this guidance or information. Please note that natural attenuation is a relatively dynamic science with ongoing research in the science and engineering community. It is important that data collectors and interpreters use the most recent regulatory guidance, which may be updated on a periodic basis from that noted in Section 6.

3.0 GLOSSARY

Aerobe: Bacteria that use oxygen as an electron acceptor.

Anaerobe: Organisms that can use electron acceptors other than molecular oxygen to support their metabolism.

Anoxic groundwater: Groundwater that contains oxygen in concentrations less than about 0.5 mg/L. This term is synonymous with the term anaerobic.

Anthropogenic: Man-made.

Cometabolism: The process in which a compound is fortuitously degraded by an enzyme or cofactor produced during microbial metabolism of another compound.

Daughter product: A compound that results directly from the biotic or abiotic degradation of another. For example, *cis*-1,2-dichloroethene (*cis*-1,2-DCE) is a common daughter product of trichloroethene (TCE).

Diffusion: The process whereby molecules move from a region of higher concentration to a region of lower concentration as a result of Brownian motion.

Dispersion: The tendency for a solute to spread from the path that it would be expected to follow under advective transport.

Electron acceptor: A compound capable of accepting electrons during oxidation-reduction reactions. Microorganisms obtain energy by transferring electrons from an electron donor such as an organic compound (or sometimes a reduced inorganic compound such as sulfide) to an electron acceptor. Electron acceptors are compounds that are relatively oxidized and include oxygen, nitrate, iron(III), manganese(IV), sulfate, carbon dioxide, or in some cases chlorinated aliphatic hydrocarbons such as tetrachloroethene (PCE), TCE, DCE and vinyl chloride (VC).

Electron donor: A compound capable of supplying (giving up) electrons during oxidation-reduction reactions. Microorganisms obtain energy by transferring electrons from an electron donor such as an organic compound (or sometimes a reduced inorganic compound such as sulfide) to an

electron acceptor. Electron donors are compounds that are relatively reduced and include fuel hydrocarbons and native organic carbon.

Metabolic byproduct: A product of the reaction between an electron donor and an electron acceptor. Metabolic byproducts include volatile fatty acids, daughter products of chlorinated aliphatic hydrocarbons, methane, and chloride.

Oxic groundwater: Groundwater that contains oxygen in concentrations greater than about 0.5 mg/L.

Oxidation/reduction reaction: A chemical or biological reaction wherein an electron is transferred from an electron donor (donor is oxidized) to an electron acceptor (acceptor is reduced).

Predominant terminal electron-accepting process: The electron-accepting process (oxygen reduction, nitrate reduction, iron(III) reduction, etc.) that sequesters the majority of the electron flow in a given system.

Reductive dechlorination: Reduction of a chlorine-containing organic compound via the replacement of chlorine with hydrogen.

Respiration: The process of coupling the oxidation of organic compounds with the reduction of inorganic compounds such as oxygen, nitrate, iron(III), manganese(IV), and sulfate.

Seepage velocity: The average velocity of groundwater in a porous medium.

Substrate: A compound used by microorganisms to obtain energy for growth. The term can refer to either an electron acceptor or an electron donor.

4.0 RESPONSIBILITIES

Project Manager (PM) / Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this standard operating procedure (SOP).

Project Hydrogeologist or Geochemist - Responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), and equipment to be used, and providing detailed input in this regard to the project plan documents. The project hydrogeologist or geochemist is also responsible for properly briefing and overseeing the performance of the site sampling personnel.

Site Manager (SM) / Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Project Geologist - is primarily responsible for the proper acquisition of the groundwater samples. He/she is also responsible for the actual analyses of onsite water quality samples, as well as instrument calibration, care, and maintenance. When appropriate, such responsibilities may be performed by other qualified personnel (e.g., field sampling technicians or site personnel).

5.0 PROCEDURES

5.1 General

Natural attenuation includes physical, chemical, and biochemical processes affecting the concentrations of dissolved contaminants in groundwater. These processes may include advection, dispersion, volatilization, dilution, sorption to aquifer solids, and/or precipitation or mineralization of compounds. Of greatest importance are those processes that lead to a reduction in contaminant mass (by degrading or destroying contaminants) such as biodegradation. These biochemical processes remove organic contaminants from the aquifer by destruction. Depending on the type of contaminant, particularly the organic contaminant (e.g., petroleum hydrocarbons or chlorinated organic solvents), the biochemical environment in the aquifer will vary. The biochemical environment within the aquifer influences and is influenced by the activities of aquifer microbiota. Specific types of microbiota, working singly or in complex consortia, may use organic contaminants as part of their normal cell functions. Natural

attenuation monitoring is designed to measure indicators of the biochemical environment within the aquifer and, with direct and indirect lines of evidence and associated chemical concentration data, evaluate the likely fate (i.e., transformation, destruction, dilution, attenuation, etc.) of organic contaminants.

5.2 Planning for Natural Attenuation Sampling

The first step in preparing a natural attenuation investigation is to develop a site-specific conceptual model. The first step in development of this model is the analysis and review of available site-specific characterization data. The development and refinement of this model should be supplemented with additional data as needed. The data should include but is not limited to:

- Geologic and hydrogeologic information in three dimensions
- Nature, extent, and magnitude of contamination
- Location and presence of potential receptors to contamination

Lines of Evidence

Several lines of evidence are used to determine whether natural attenuation is working. The most compelling, primary evidence is decreasing groundwater contaminant concentrations over time. Decreasing concentration trends can be demonstrated in several ways including:

- Isoconcentration maps of the dissolved plume over time wherein the extent of the plume is either stable or decreasing.

- Time series plots of contaminant concentrations within a well illustrating a clear downward trend.

- Contaminant concentration profiles in a series of monitoring wells along a groundwater flow path illustrating decreasing concentrations beyond that attributable to dilution and dispersion.

Secondary, or supporting, lines of evidence include:

- Analytical data showing production and subsequent destruction of primary contaminant breakdown products.

- Geochemical data indicating that the biochemical environment is favorable for the appropriate microbiota.

- Geochemical data that indicate the aquifer microbiota are active.

Monitoring Well Location and Sampling Frequency

The number and locations of wells required to monitor natural attenuation will depend on the physical setting at each location. One possible array of monitoring wells is illustrated in Attachment A. In this scenario, one well is used to monitor conditions upgradient of the source, one well is located in the source area, and several wells are used to define and monitor the downgradient and lateral extent of the dissolved plume. At a minimum, there should be at least one upgradient well (ideally with no contamination present), one well in the source area, one well downgradient from the source area in the dissolved plume, and one downgradient well where contaminant concentrations are below regulatory criteria. Note that the number and locations of monitoring wells will vary depending on the site complexity and site objectives.

Sampling frequency will be dictated by the ultimate use of the data and site-specific characteristics. Contaminant concentrations may be used to define statistically meaningful trends in contaminant concentrations. The sampling frequency may be defined by the hydrogeologic and/or geochemical conditions as well as the proposed statistical method for data analysis. For example, groundwater flow and contaminant characteristics (e.g., seepage velocity and contaminant loading) may dictate the sample frequency. Regardless of the factors, sampling frequency and duration will need to establish the range of natural chemical variability within the aquifer. After a sufficient amount of data has been collected and the geochemical conditions are understood, the frequency of sampling may be reduced. See Section 5.4 for additional information on sample collection and frequency.

5.3 Selection of Natural Attenuation Parameters

Natural attenuation via biodegradation depends on the nature of the organic contaminants and the oxidation-reduction (redox) environment within the aquifer. Simply stated, if the contaminants are fuels, biodegradation will be most effective if the redox conditions are aerobic or oxidizing. If the contaminants are chlorinated solvents, the biodegradation will be most effective (in the source and near source areas) if redox conditions in the aquifer are anaerobic or reducing.

Several parameters are needed to evaluate whether natural attenuation is taking place and, if so, the rate at which it may be occurring. The primary parameter providing direct evidence of natural attenuation is the aqueous concentrations of parent and daughter volatile organic compounds. More specifically, a decrease in percent products, an increase in daughter products, evidence that the plume is stable or shrinking in size, and overall decline in contaminant concentrations is direct evidence of natural attenuation. Natural attenuation or geochemical parameters that provide information about the redox conditions in the aquifer include:

- Dissolved oxygen
- Nitrate/nitrite
- Dissolved manganese
- Iron
- Sulfate/sulfide
- Methane
- Oxidation-reduction potential (ORP)

Secondary parameters that indicate biological activity in the aquifer and thereby support the natural attenuation evaluation include:

- Dissolved hydrogen
- Alkalinity
- Dissolved carbon dioxide

The concentrations of natural attenuation parameters are used to define the aquifer redox conditions. It is important to record and document the presence or absence (i.e., measurable or not measurable concentration) of certain natural attenuation parameters. The presence or absence of a certain substance may be sufficient to indicate the redox condition within the aquifer. By reference to Attachment B, which illustrates the typical sequence of biologically mediated redox reactions in natural systems, it is apparent that, for example, sulfate reduction (producing dissolved sulfide in groundwater) does not operate in an aerobic environment. Therefore, measurable sulfide should not be present if there is also dissolved oxygen at concentrations indicating an aerobic environment. Attachment B also illustrates the redox potential (measured in millivolts) associated with the redox reactions. ORP readings, also in millivolts, measured during well purging, may be compared with the range of values in Attachment B but with caution. Redox potentials measured with a platinum electrode in natural water samples may be misleading, especially when biologically mediated reactions are important, because many of the critical

reactions in Attachment B do not generate a response in the electrode. Dissolved hydrogen concentration ranges associated with important redox reactions are also indicated in Attachment B. Because dissolved hydrogen is actually used by microbiota during redox reactions, its concentration may provide an additional indicator of the overall redox condition in the aquifer.

Attachments C and D tabulate the natural attenuation parameters for chlorinated volatile organic compound and petroleum hydrocarbon plumes, respectively. The parameters listed in these tables are organized in order of importance. Parameters selected for analysis shall be determined based on site conditions, project-specific plans, and/or other criteria established for the project. Based on these criteria, it is possible that all of the parameters may be selected.

5.4 Selection of Natural Attenuation Analytical Methods and Procedures

There are many analytical methods available to measure concentrations of the natural attenuation parameters discussed in the previous sections. Attachment E summarizes the sample methodologies, sampling equipment needed, sample volume, container, preservation, and holding time requirements. This table also summarizes the detection limits and the detection ranges for each method. A number of factors should be considered when selecting the appropriate sample analytical methodology including the required parameters, appropriate detection ranges for each compound, cost, and ease of use in the field. For example, when determining the correct methodology for measuring concentrations of total sulfide, the metabolic byproduct of sulfate reducing conditions, it is important to analyze for each of the forms of sulfide (H_2S, S^{-2}, and HS^-). Also, when the detection limit of the selected method is exceeded, another method may be considered, or the sampler may be able to dilute the sample (per manufacturer's instructions) to quantify it within the detected range. In terms of cost, some parameters are very time consuming when performed in the field. Without sacrificing sample integrity it may be more appropriate to select a methodology performed in a fixed-base laboratory. Finally, in terms of ease of use, certain field methods are generally easier compared to other methods. Using simpler methods may result in better quality sample results and increased sample repeatability without sacrificing sample integrity. For example, in some cases CHEMetrics Titret® Titration Ampule kits may be a good alternative to other hand digital titration methods.

The sample technicians should be aware that based on geochemical conditions recorded in the field, certain geochemical parameters may not have positive detections. For example, if dissolved oxygen concentrations indicate aerobic conditions then it is unlikely that dissolved hydrogen is present (see Section 5.10 for additional information). Another example is alkalinity. If the pH of the groundwater sample is less than 4.5, then it is unlikely that alkalinity will be measurable. Despite the potential for non-detect results, in cases such as those described above, all parameters should be collected in the field based upon project plans. The value in collecting the parameters in the future shall be determined by the project hydrogeologist and/or geochemist in accordance with the projects planning documents data quality objectives (DQO) and the items discussed in Section 5.2.

5.5 Procedures for Sample Collection

Groundwater sample collection for natural attenuation sampling should be performed using low flow purging and sampling techniques. These techniques are described in detail in SOP SA-1.1. Low flow purging and sampling procedures should be used to ensure the collection of a sample that is "representative" of the water present in the aquifer formation. Minimizing stress on the aquifer formation during low flow purging and sample collection ensures that there are minimal alternations to the water chemistry of the sample. The criteria used in the purging process should include minimization of drawdown in the well, stabilization of applicable indicator parameters, and evacuation of a sufficient amount of purge volume in accordance with SOP SA-1.1, project plans, and/or applicable regulatory guidance.

Groundwater purging and sampling for natural attenuation should be performed using submersible pumps (e.g., bladder pumps) in accordance with SOP SA-1.1. However, in accordance with project plans and applicable regulatory guidance, peristaltic pumps may also be used for this purpose. Limitations of and factors associated with using these devices should be considered (see SOP SA-1.1 for more information). As a result of difficulties in collecting “representative” groundwater samples, bailers should not be used for the collection of natural attenuation samples.

It is critical that disturbance and aeration of samples monitored and collected at the well head are minimized. As a result, a flow-through sampling cell and a direct reading meter shall be used for the measurement of well stabilization indicator parameters (e.g., pH, conductivity, temperature, dissolved oxygen, turbidity, and ORP) at the well head. The pump effluent tubing should be placed at the bottom of the flow-through cell allowing effluent water from the cell to discharge at the top of the meter (above the detector probes) to minimize the agitation of water in the cell.

Documentation of the purging process shall be recorded during and at the completion of purging as discussed in Section 5.8. Immediately following the purging process and before sampling, all applicable indicator parameters must be measured and recorded on the appropriate sample log sheets as discussed in Section 5.8.

After all of the purging requirements have been met, groundwater sampling and natural attenuation data collection can begin. Monitoring wells will be sampled using the same pump and tubing used during well purging.

5.6 Procedures for Field Sample Analysis

Each of the field and fixed-base laboratory sample parameters requires different sampling procedures and holding times. Attachment E presents parameter-specific requirements for sampling, analysis, and storage of all of the parameters and methods sampled as part of natural attenuation analysis.

Due to parameter procedure and holding times, it is important to consider the sequence of sample collection and analysis. Generally speaking, with the exception of volatile organic compounds, field parameters shall be analyzed first followed by fixed-base laboratory sample collection. All samples will be collected in a sequence and manner that minimizes volatilization, oxidation, and/or chemical transformation of compounds. As a result, the following sample and analysis order should be followed:

1. Volatile organic compounds
2. Dissolved oxygen
3. Alkalinity
4. Dissolved carbon dioxide
5. Dissolved ferrous iron
6. Dissolved sulfide (hydrogen sulfide and sulfide)
7. Dissolved hydrogen, methane, ethene, and ethane
8. Nitrate / Nitrite
9. Dissolved manganese
10. Semivolatile organic compounds
11. Other dissolved metals
12. Total metals
13. All other constituents

Field-analyzed parameters should be collected and immediately analyzed directly from the pump effluent per the requirements on Attachment E and manufacturer's recommendations. Care should be taken to minimize any unnecessary disturbance, aeration, or agitation of the sample prior to analysis. It is not acceptable to collect and store samples that are to be analyzed immediately at the well head in a temporary holding container (e.g., open topped pitcher) to be analyzed at a later time.

The manufacturer’s procedure manual for each of the field-based analyses shall be maintained in the field during the entire sampling program. The procedures give a detailed explanation of how to perform each particular method and include information on sampling, storage, accuracy checks, interferences, reagents, and apparatus needed to perform each analysis.

5.7 Procedures for Quality Assurance and Quality Control Field Sample Analysis

Accuracy and precision checks shall be performed to check the performance of the reagents, apparatus, and field analytical procedures per the manufacturer's recommendations. The accuracy checks should include the use of standard solutions (i.e., standard addition), as appropriate. The manufacturer's field test kit manual provides details on how to perform each of the accuracy checks for each parameter where applicable. Refer to Section 6.0 for manufacturer contact information.

Precision checks must include the performance of duplicate analysis. When using a colorimeter, precision checks may also include reagent blank corrections and standard curve adjustments as recommended by the manufacturer. Field duplicate results shall be performed and evaluated for relative percent difference (RPD) at a rate of 1 per 10 samples or as determined by the project plans. The RPD can be calculated as follows:

$$\text{RPD} = \left| \frac{\text{First result - Second result}}{\text{Mean arithmetic (average) of first and second result}} \right| \text{x } 100$$

If the RPD exceeds 50 percent, it is required that the test be performed again to verify the result. The duplicate results shall be documented in the 'Notes' section for that specific parameter on the appropriate sample logsheet (see Section 5.8).

If a colorimeter (e.g., HACH DR-890 or equivalent) is used for parameter analysis, an instrument performance verification test using absorbance standards may also be performed to ensure the meter is providing accurate measurements.

The following table lists examples of the types and frequencies of accuracy checks required for each parameter. Refer to the manufacturer's instructions for information regarding other analyses.

Parameter	Method	Standard Solution	Field Duplicate	Reagent Blank Correction
Alkalinity	CHEMetrics K-9810, -15, -20	None	1 per 10	None
Carbon dioxide	CHEMetrics K-1910, -20, -25	None	1 per 10	None
Dissolved oxygen	CHEMetrics K-7501, -12	None	1 per 10	None
Ferrous iron	HACH DR-890	None	1 per 10	None
Nitrite	HACH DR-890	1 per round	1 per 10	1 per lot
Nitrate	HACH DR-890	1 per round	1 per 10	1 per lot
Sulfide	HACH DR-890	None	1 per 10	None
Hydrogen sulfide	HACH HS-C	None	1 per 10	None

Prior to analysis, the expiration dates of reagents shall be checked. If the reagents have exceeded their expiration date or shelf life, the reagents shall be replaced. If deviations from the applicable analytical procedure are identified, the deviations shall be corrected and the associated samples re-analyzed. If problems are identified with the reagents, apparatus, or procedures, data interferences may be present. Interferences may also be due to other factors (e.g., pH, presence or concentration of other ions, turbidity, temperature, etc.) that may interfere with the sample result. The manufacturer's procedures (e.g., Hach,

1999) should be reviewed prior to analysis to avoid or minimize such interferences. Associated problems or suspected interferences shall be documented in the 'Notes' section of the sample logsheet. Often, interferences cannot be avoided. In these cases, the sampler should be aware of these potential interferences and document them properly.

5.8 Documentation Procedures for Field Sample Analysis

Field results shall be properly documented in the field as noted in SOP SA-6.3. The sample log sheet titled "Field Analytical Log Sheet, Geochemical Parameters" shall be prepared for each sample collected and analyzed in the field. A copy of this form can be found as Attachment F of this SOP. Other field log sheets (e.g., low flow purge log sheet, groundwater sample logsheet, etc.) shall also be completed in accordance with SOP SA-6.3.

Specific information shall also be recorded in the project logbook. This information shall include, but is not limited to, the test kit name and model number, lot number and expiration date of the test kit and reagents used, serial number of the instrument (e.g., colorimeter) used for the analysis, and results of the quality assurance and quality control field sample analysis. Because environmental conditions and changes in those conditions may affect the field analytical results, it is important to document the site conditions (weather, temperature, etc.) at the time of sampling in the logbook in accordance with SOP SA-6.3.

5.9 Waste Handling and Disposal

Several of the test kits listed in Attachment E require the use of chemicals and materials that must be properly handled and disposed of in a proper and responsible manner. Refer to specific manufacturer's guidance for handling and disposal practices. See also Section 6.0 for more detailed and complete information. Handling and disposal of these items should be conducted in accordance with all local, state, and federal guidelines.

5.10 Understanding Field Sample Analytical Results

Natural attenuation data interpretation is complicated by the complex inter-relationships of various parameters. The complexity reflects the myriad of biochemical processes. Real-time evaluation of field analytical data can be misleading because a full interpretation often requires combining the field analytical results with fixed-base laboratory results. Regardless, some simple observations and data interpretations in the field may provide insights about the monitoring system or early warnings about sample collection and handling problems.

Data collected from the designated upgradient monitoring well is the baseline from which other interpretations are made. Field analytical data will indicate that the upgradient environment is either oxidizing or reducing. The redox condition within the upgradient area of the aquifer may be natural or impacted by other contaminant source areas (see Section 5.2 for upgradient well selection). Regardless, the redox condition of the upgradient groundwater will influence the source area. Changes in field analytical results from the upgradient well to the source area well will be reflected in samples from monitoring wells further downgradient.

The general characteristics of the two redox environments are summarized in the following table.

Aerobic/Oxidizing	Anaerobic/Reducing
• Measurable dissolved oxygen (>1 to 2 ppm)	• No measurable dissolved oxygen (<1 ppm)
• Measurable nitrate	• No measurable nitrate
• No measurable dissolved manganese	• Measurable dissolved manganese
• No measurable dissolved ferrous iron	• Measurable dissolved ferrous iron
• Measurable dissolved sulfate	• No measurable dissolved sulfate
• No measurable dissolved sulfide	• Measurable dissolved sulfide
• No measurable dissolved methane	• Measurable dissolved methane
• No measurable dissolved hydrogen	• Measurable dissolved hydrogen

Transitional environments between these two extremes may have intermediate characteristics and are actually quite common. Because reactions are mediated by biological systems, equilibrium (the basis for the figure in Attachment B) conditions within the aquifer should not be expected. For example, sulfate reduction environments may occur in close proximity to methanogenic environments, and this natural attenuation data may be difficult to interpret. Carefully collected and analyzed field measurements and sample collections for fixed-base laboratory analyses are designed to characterize the aquifer environment along the continuum between strongly aerobic and strongly anaerobic. Because the land surface environment is generally more oxidizing than any groundwater environment, sample handling at the point of collection and analysis is extremely important in preserving the chemical integrity of the groundwater sample.

6.0 REFERENCES

American Society for Testing and Materials (ASTM), 1998. Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites, Designation: E1943-98, West Conshohocken, Pennsylvania.

Chemetrics, 2002, http://www.chemetrics.com.

Department of the Navy, 1998. Technical Guidelines for Evaluating Monitored Natural Attenuation of Petroleum Hydrocarbons and Chlorinated Solvents in Ground Water at Naval and Marine Corps Facilities, Department of the Navy, September. Prepared by T. H. Weidemeier and F. H. Chappelle.

USEPA (United States Environmental Protection Agency), 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, EPA/600/R-98/128, Office of Research and Development, Washington, D.C.

Hach Company, 1999. DR-890 Colorimeter Procedures Manual, Product Number 48470-22, Loveland Colorado.

Hach Company, 1999. Digital Titrator (manual), Model Number 16900, Catalog Number 16900-08. Loveland, Colorado.

Hach Company, 2002, http://www.hach.com/.

USEPA, 1997. Draft EPA Region 4 Suggested Practices for Evaluation of a Site for Natural Attenuation (Biological Degradation) of Chlorinated Solvents; Version 3.0. November.

USEPA, 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, USEPA OSWER Directive 9200.4-17P, April 21, 1999

ATTACHMENT A

HYPOTHETICAL LONG-TERM MONITORING STRATEGY

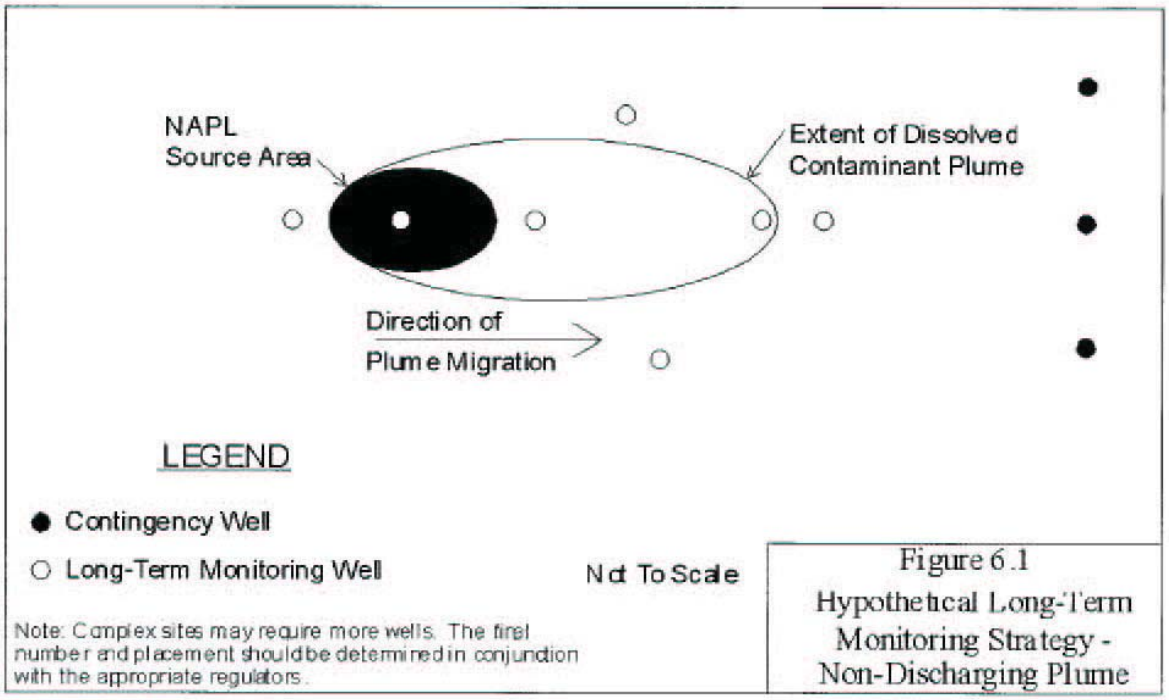

Figure 6.1
Hypothetical Long-Term Monitoring Strategy - Non-Discharging Plume

Taken from: Department of the Navy, 1998, Technical Guidelines for Evaluating Monitored Natural Attenuation of Petroleum Hydrocarbons and Chlorinated Solvents in Ground Water at Naval and Marine Corps Facilities, Prepared by Todd Weidemeier and Francis Chappelle.

ATTACHMENT B

REDOX POTENTIALS FOR VARIOUS ELECTRON ACCEPTORS

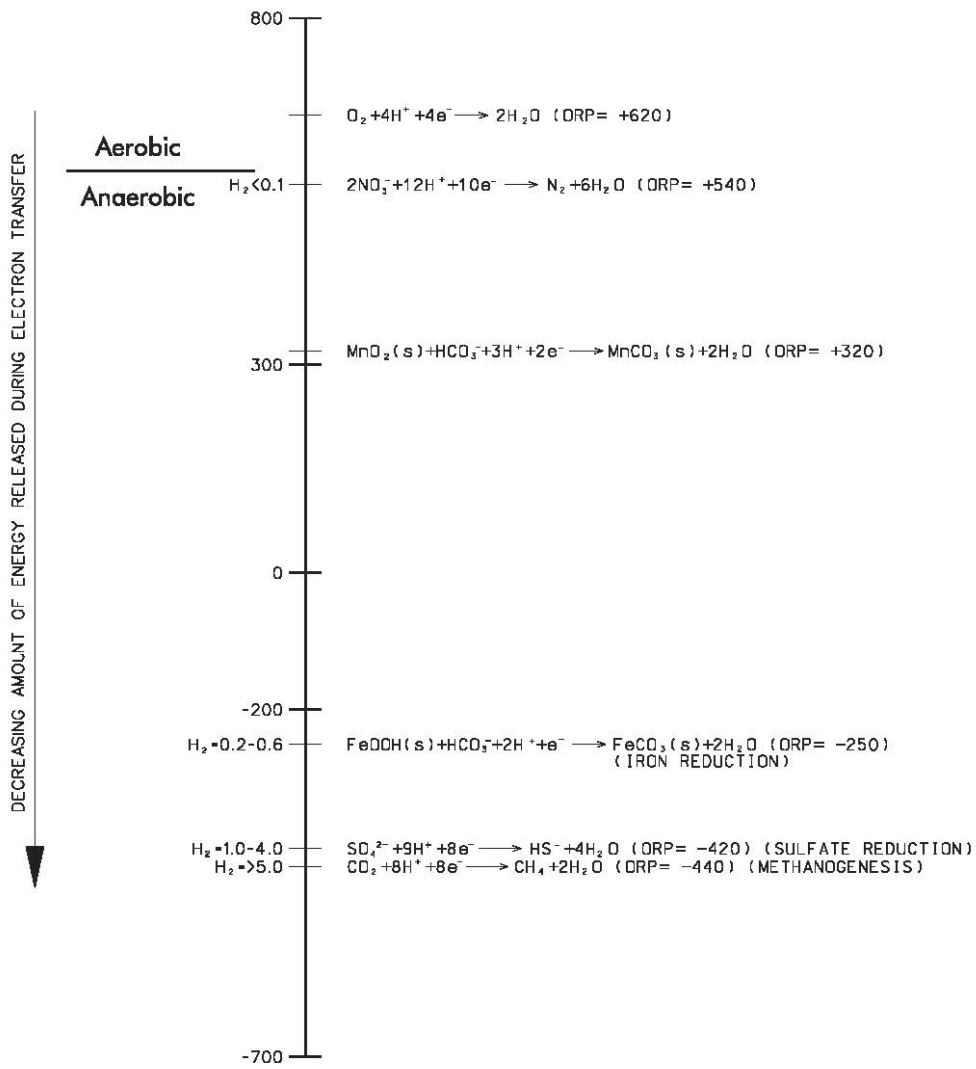

FIGURE B
REDOX POTENTIALS
FOR VARIOUS ELECTRON ACCEPTORS

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ATTACHMENT C

NATURAL ATTENUATION PARAMETERS FOR CHLORINATED VOLATILE ORGANIC COMPOUND PLUMES SCREENING PROCESS SUMMARY FOR REDUCTIVE (ANAEROBIC) DECHLORINATION

Potential Electron Donors	Electron Acceptors:		Reduced Species:		Related Dechlorination Pathway:
	Dissolved Oxygen	⇒	Carbon Dioxide (CO_2)	~	DCE → VC → CO_2
Native total organic carbon (TOC)	Manganese (Mn^{4+})	⇒	Manganese (Mn^{2+})	~	DCE → VC
Anthropogenic carbon (e.g., leachate)	Nitrate (NO_3)	⇒	Nitrite (NO_2)	~	DCE → VC
Fuel hydrocarbons (e.g., BTEX)	Ferric Iron (Fe^{3+})	⇒	Ferrous Iron (Fe^{2+})	~	DCE → VC → CO_2
Lightly chlorinated solvents (DCE/VC)	Sulfate (SO_4)	⇒	Sulfide (S^{2-}, HS^-, H_2S)	~	TCE → DCE → VC → Ethene
	Carbon Dioxide (CO_2)	⇒	Methane (CH_4)	~	PCE → TCE → DCE → VC → Ethene

Geochemical Parameter List:

Parameter	Field or Lab	Rationale	Importance
Volatile organic compounds	L	Source products; daughter products; electron donors (e.g., benzene, toluene, ethylbenzene, and xylene; BTEX)	1
Dissolved oxygen	F	Primary electron acceptor (respiration); an/aerobic indicator	1
Nitrate (and nitrite), dissolved	F or L	Anaerobic electron acceptor (product of nitrate reduction)	1
Manganese, dissolved	F or L	Anaerobic electron acceptor	1
Ferrous Iron (Fe^{2+})	F	Product of iron reduction	1
Sulfate [and sulfide (S^{-2})]	F or L	Common anaerobic electron acceptor (product of sulfate reduction)	1
Sulfide (H_2S)	F	Common product of sulfate reduction	1
Methane, ethane, ethene	L	Product of methanogenesis; daughter products of reductive dechlorination	1
Chloride	L	Ultimate daughter product of reductive dechlorination	1
TOC - upgradient groundwater	L	Electron donor	1
ORP, pH, specific conductance, temperature, turbidity	F	General water quality determination	1
Carbon dioxide (CO_2)	F	Anaerobic electron acceptor (methanogenesis); biotic respiration indicator	2
Alkalinity/DIC	F	Buffering capacity; biotic respiration indicator	2
Hydrogen, dissolved	L	Fingerprint for characterizing electron acceptor pathway - indicator of what redox is occurring	2
TOC - upgradient soil	L	Input to analytical NA models; quantifies soil-water distribution coefficient and retardation factor	2
Volatile fatty acids	L	Determination of anthropogenic carbon used as an electron donor	3

Importance: 1=Most important; 3=Least important (depending on DQOs, all may be recommended).
See Attachment E for details regarding analytical methods.

ATTACHMENT D

NATURAL ATTENUATION PARAMETERS FOR PETROLEUM HYDROCARBON PLUMES SCREENING PROCESS SUMMARY FOR OXIDATIVE (AEROBIC) DEGRADATION

Parameter	Field or Lab	Rationale	Importance
Volatile organic compounds	L	Source products; daughter products; electron donors (BTEX)	1
Dissolved oxygen	F	Primary electron acceptor (respiration); an/aerobic indicator	1
Nitrate (and nitrite), dissolved	F or L	Anaerobic electron acceptor (and product of nitrate reduction)	1
Manganese, dissolved	F or L	Anaerobic electron acceptor	1
Ferrous Iron (Fe^{2+})	F	Product of iron reduction	1
Sulfate [and Sulfide (S^{-2})]	F or L	Common anaerobic electron acceptor (product of sulfate reduction)	1
Sulfide (H_2S)	F	Common product of sulfate reduction	1
TOC - upgradient groundwater	L	Electron donor	1
ORP, pH, specific conductance temperature, turbidity	F	General water quality determination	1
Dissolved methane (CH_4)	L	Product of methanogenesis	1
Anions: chloride (Cl), nitrate (NO_3), nitrite (NO_2), phosphate (PO_4), sulfate (SO_4)	L		1
TOC - Upgradient soil	L	Input to analytical NA models; quantifies soil-water distribution coefficient and retardation factor	2
Biological oxygen demand (BOD)	L	Understanding of aquifer oxygen demand	3
Chemical oxygen demand (COD)	L	Understanding of aquifer oxygen demand	3

Importance: 1=Most important; 3=Least important (depending on DQOs, all may be recommended).

See Attachment E for details regarding analytical methods.

ATTACHMENT E
GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUMES, CONTAINERS, PRESERVATION, HOLDING TIMES, AND DETECTION RANGES
PAGE 1 OF 4

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Alkalinity	CHEMetrics K-9810, K-9815, K-9820 -ASTM D 1067-92 -EPA 310.1	Titret® Titration Ampules / Hydrochloric Acid, Phenolphthalein	Field. Follow test kit instructions. Avoid agitation and analyze at well head to determine total alkalinity. Filter if turbid (>10 NTU).	10-100 (K-9810) 50-500 (K-9815) 100-1000 (K-9820)	N/A	10 50 100-
Alkalinity	Fixed-base lab -EPA 310.1	N/A	100 to 250 mL in glass or plastic container. Cool to 4°C. Analyze within 14 days. Filter if turbid.	N/A	N/A	N/A
Alkalinity / Dissolved Inorganic Carbon	HACH AL-DT -HACH 8203 -SM 2320 / SM 403	Digital Titration / Hydrochloric Acid, Phenolphthalein (P) and Total (M)	Field. Follow test kit instructions. Avoid agitation and analyze at well head to determine carbonate, bicarbonate, and hydroxide ions. Filter if turbid as recommended by manufacture. May use a pH meter for colored samples.	10-4000	N/A	10
Arsenic	Fixed-base lab -SW-6010 B	N/A	1 liter glass or polyethylene container, HNO_3 to pH $\leq$ 2, 6 months.	N/A	N/A	N/A
Biochemical Oxygen Demand	Fixed-base lab -EPA 410.1	N/A	2 liter HDPE. Cool to 4°C. Analyze within 48 hours.	N/A	N/A	N/A
Carbon Dioxide, dissolved	CHEMetrics K-1910, K-1920, K-1925 -ASTM D 513.82 -SM 4500-CO_2-C	Titret® Titration Ampules / Sodium Hydroxide, Phenolphthalein	Field. Follow test kit instructions. Avoid agitation and analyze at well head.	10-100 (K-1910) 100-1000 (K-1920) 250-2500 (K-1925)	N/A	10 100 250
Carbon Dioxide, dissolved	Fixed-base lab - VOA water sample (Vaportech)	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Carbon Dioxide, dissolved	Fixed-base lab -Microseeps gas stripping cell	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Carbon Dioxide, dissolved	HACH CA-DT -HACH 8205 -Mod. SM 406	Digital Titration / Sodium Hydroxide, Phenolphthalein	Field. Follow test kit instructions. Do not aerate or agitate. Analyze at well head.	10-1000	N/A	10
Chemical Oxygen Demand	Fixed-base lab -EPA 410.1	N/A	125 mL HDPE. H_2SO_4 to pH <2.0. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Chloride (Cl)	Fixed-base lab -EPA 300	N/A	100 to 250 mL in glass or plastic container. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Chlorine - Total (Cl_2)	HACH DR-850 -HACH 8167 -SM 4500-Cl	Colorimeter / DPD Method	Field. Follow test kit instructions.	0.02-2.00	$\pm$ 0.01 mg/L with a 1.00 mg/L chlorine solution.	1
Conductance, Specific	Field Meter -SW-9050 A	Direct Reading Meter	100 to 250 mL in glass or plastic container. Analyze immediately.	N/A	N/A	N/A
Ethane, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 toi 3 vials by (Vaportech).	N/A	N/A	N/A
Ethane, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A

ATTACHMENT E

GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER, PRESERVATION, HOLDING TIME, AND DETECTION RANGES

PAGE 2 OF 4

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Ethene, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Ethene, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Fraction Organic Carbon (foc) -Soil Upgradient Saturated Soil	Fixed-base lab -Walk-Black -SW-846 9060	N/A	200 gram glass jar. Cool to 4°C. Analyze within 14 days.	N/A	N/A	N/A
Hydrogen, dissolved	Fixed-base lab -Microseeps or Vapor Tech gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial.	N/A	N/A	N/A
Iron, ferrous (Fe^{+2})	HACH DR-850 -HACH 8146 -Mod. SM 315 B	Colorimeter 1, 10 Phenanthrolein	Field. Follow test kit instructions. Analyze immediately at well head. Filter if turbid (>10 NTU) as recommended by the manufacture.	0-3.00	±0.017 mg/L with a 2.00 mg/L Fe^{2+} solution.	0.03
Iron, ferrous (Fe^{+2})	HACH IR-18C -Mod. SM 315 B	Color Disc 1, 10 Phenanthrolein	Field. Follow test kit instructions. Analyze immediately at well head. Filter if turbid (>10 NTU) as recommended by the manufacture.	0-10	N/A	0.2
Iron, total dissolved (Filtered)	Fixed-base lab -SW-846 6010B	N/A	250 mL in plastic container. Field filter to 0.45 µ. HCl to pH <2. Cool to 4°C. Analyze within 6 months.	N/A	N/A	N/A
Manganese (Mn^{+2})	HACH DR-850 -HACH 8034 -CFR 44(116) 34193	Colorimeter / Cold Periodate Oxidation	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-20.0	± 0.18 mg/L with a 10.00 mg/L Mn solution.	0.12
Manganese (Mn^{+2})	HACH MN-5 -Mod. SM 319 B -CFR 44(116) 34193	Color Disc / Cold Periodate Oxidation	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-3	N/A	0.1
Manganese, total dissolved (Filtered)	Fixed-base lab -SW-846 6010B	N/A	250 mL in plastic container. Field filter to 0.45 µ. HCl to pH <2. Cool to 4°C. Analyze within 6 months.	N/A	N/A	N/A
Methane, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Methane, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Nitrate (NO_3^-)	Fixed-base lab -EPA 300	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours.	N/A	N/A	N/A
Nitrate (NO_3^-)	HACH DR-850 -HACH 8192 -Mod. EPA 353.2	Colorimeter / Cadmium Reduction	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Pretreatment required if nitrite is present.	0-0.50	± 0.03 mg/L with a 0.25 mg/L of nitrate nitrogen (NO_3^- N) solution.	0.01
Nitrite (NO_2^-)	Fixed-base lab -EPA 300	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A

ATTACHMENT E

GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER, PRESERVATION, HOLDING TIME, AND DETECTION RANGES

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Nitrite (NO_2^-)	HACH DR-850 -HACH 8507 -Mod. EPA 354.1 -Mod. SM 419 -CFR 44(85) 25595	Colorimeter / Diazotization	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-0.350	± 0.001 mg/L with a 0.250 mg/L nitrite nitrogen solution.	0.005
Nitrogen, dissolved	Fixed-base lab -Microseeps gas stripping cell - Vaportech VOA water sample	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required for Microseeps. Ship in glass septum vial (Microseeps) or VOA vial (Vaportech).	N/A	N/A	N/A
Nitrogen, Total Kjeldahl	Fixed-base lab -EPA 351.2	N/A	500 mL plastic/glass container. Cool to 4°C. H_2SO_4 to pH ≤ 2. Analyze within 28 days.	N/A	N/A	N/A
Oxidation Reduction Potential	Field Meter - ASTM D-1498	Direct Reading Meter	Field. Do not aerate. Gently agitate probe using flow over ot flow-through method. Analyze immediately at well head.	N/A	N/A	N/A
Oxygen, dissolved	CHEMetrics K-7501, K-7512 -ASTM D 5543-94 -ASTM D 887-92	CHEMets® Vacuum Vials / Rhodazine D and Indigo Carmine	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-1 (K-7501) 1-12 (K-7512)	N/A	0.025 1
Oxygen, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Oxygen, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Oxygen, dissolved	HACH OX-DT -HACH 8215 -SM 4500-O-G	Digital Titration / Azide Modification of Winkler Digital Titration Method	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	1-10	N/A	1
Oxygen, dissolved	HACH DR-850 (AccuVac Ampules) LR HRDO Method	-Indigo Carmine Method -Rhadazine D Method	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-0.8 ppm 0-10 ppm	0.01 ppm 0.1 ppm	N/A
Oxygen, dissolved	Field Meter	Direct Reading Meter	Analyze immediately at well head. Avoid agitation and analyze immediately at well head. Used for well stabilization measurement parameter only.	N/A	N/A	N/A
pH	Field Meter -SW 9040B	Direct Reading Meter	Analyze immediately at well head.	N/A	N/A	N/A
Phosphate (ortho)	Fixed-base lab -EPA 300	Ion Chromatography	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Phosphate, potassium	Fixed-base lab -SW-846 6010B	Inductively Coupled Plasma	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Salinity	Field Meter	Direct Reading Meter	Analyze immediately.	N/A	N/A	N/A
Sulfate (SO_4^{-2})	Fixed-base lab	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Sulfate (SO_4^{-2})	HACH DR-850 -HACH 8051 -EPA 375.4	Colorimeter / Turbimetric SulfaVer 4	Field. Follow test kit instructions. Filter if turbid as recommended by the manufacture.	0-70	± 0.5 mg/L with a 50 mg/L sulfate solution.	4.9
Sulfide (Hydrogen Sulfide, H_2S)	HACH HS-C -HACH Proprietary -Mod. SM 426 C	Color Chart / Effervescence of H_2S through sulfide reactive paper.	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-5	N/A	0.1
Sulfide (S^{-2})	CHEMetrics K-9510 -SM 4500-S^2	CHEMets® Vacuum Vials / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-1 1-10	N/A	0.1 1

ATTACHMENT E

GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER, PRESERVATION, HOLDING TIME, AND DETECTION RANGES

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Sulfide (S^{-2})	Fixed-base lab -EPA 376.1/376.2	N/A	1 liter in plastic container, no headspace. NaOH to pH >9. Cool to 4°C. Avoid agitation and analyze within 7 days.	N/A	N/A	N/A
Sulfide (S^{-2})	HACH DR-850 -HACH 8131 -SM 4500-S^{-2}	Colorimeter / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head. Pretreatment required for turbid samples as recommended by the manufacture.	0-0.70	± 0.02 mg/L with a 0.73 mg/L sulfide solution.	0.01
Sulfide (S^{-2})	HACH HS-WR -SM 4500-S^{-2}	Color Disc / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head. Pretreatment required for turbid samples as recommended by the manufacture.	0-11.25	N/A	0.1-2.5
Temperature	Field Meter / Thermometer - E170.1	Direct Reading Meter / Thermometer	Analyze immediately.	N/A	N/A	N/A
Total Organic Carbon (TOC)-Groundwater	Fixed-base lab -E 415.1	N/A	125 mL HDPE. H_2SO_4 to pH < 2.0. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Turbidity	Field Meter - E 180.1	Direct Reading Meter	Analyze immediately.	N/A	N/A	N/A

N/A = Not applicable.

ATTACHMENT F

FIELD ANALYTICAL LOG SHEET, GEOCHEMICAL PARAMETERS
PAGE 1 OF 3

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Page __ of __

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): _____

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	ORP (Eh)
Time:	(Visual)	(S.U.)	(mS/cm)	(^{0}C)	(NTU)	(mg/l)	(%)	(+/- mv)
Method:								

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model:_____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-7510	
☐	1 to 12 ppm	K-7512	

Analysis Time: _____

Equipment: HACH Digital Titrator OX-DT

Analysis Time:_____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	1-5 mg/L	200 ml	0.200 N	0.01
☐	2-10 mg/L	100 ml	0.200 N	0.02

Titration Count	Multiplier		Concentration
_____	x 0.01	=	mg/L
_____	x 0.02	=	mg/L

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-1910	
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: _____

Equipment: HACH Digital Titrator CA-DT

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	10-50 mg/L	200 ml	0.3636 N	0.1
☐	20-100 mg/L	100 ml	0.3636 N	0.2
☐	100-400 mg/L	200 ml	3.636 N	1.0
☐	200-1000 mg/L	100 ml	3.636 N	2.0

Titration Count			Concentration
_____	x 0.1	=	mg/L
_____	x 0.2	=	mg/L
_____	x 1.0	=	mg/L
_____	x 2.0	=	mg/L

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Notes:

Hydrogen, dissolved

Equipment: Bubble strip sampling field method

Start stripper at _____ (time)

End stripper at _____ (time)

Total stripper time _____

Pump rate _____ milliliters/minute

FIELD ANALYTICAL LOG SHEET, GEOCHEMICAL PARAMETERS
PAGE 2 OF 3

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Page __ of __

Project Site Name: _____ Sample ID No.: _____
Project No.: _____ Sample Location: _____
Sampled By: _____ Duplicate: ☐
Field Analyst: _____ Blank: ☐

Alkalinity:

Equipment: Chemetrics Test Kit Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☐	50 to 500 ppm	K-9815	
☐	100 to 1000 ppm	K-9820	

Analysis Time: _____

Filtered: ☐

Equipment: HACH Digital Titrator AL-DT

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
☐	10-40 mg/L	100 ml	0.1600 N	0.1	_____ & _____	x 0.1	= mg/L
☐	40-160 mg/L	25 ml	0.1600 N	0.4	_____ & _____	x 0.4	= mg/L
☐	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0	= mg/L
☐	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0	= mg/L
☐	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0	= mg/L
☐	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0	= mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 _ _ Range: 0 - 3.00 mg/L Concentration: _____ ppm
Program/Module: 500nm 33
Analysis Time: _____
Equipment: IR-18C Color Wheel Range: 0 - 10 mg/L
Notes: Filtered: ☐

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____ Concentration: _____ ppm
Exceeded 5.0 mg/L range on color chart: ☐ Analysis Time: _____

Notes:

Sulfide (S^{2-}):

Equipment: Chemetrics Test Kit Range: 0 - 10 mg/L Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-9510	
☐	1 to 10 ppm	K-9510	

Analysis Time: _____

Filtered: ☐

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.70 mg/L
Program/Module: 610nm 93

Notes:

ATTACHMENT F

FIELD ANALYTICAL LOG SHEET, GEOCHEMICAL PARAMETERS
PAGE 3 OF 3

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Page __ of __

Project Site Name: _____ Sample ID No.: _____
Project No.: _____ Sample Location: _____
Sampled By: _____ Duplicate: ☐
Field Analyst: Blank: ☐

Sulfate ($S0_4^{2-}$):

Equipment: DR-850 DR-8 _ _ Range: 0 - 70 mg/L Concentration: _____ ppm
Program/Module: _____ 91 Analysis Time: _____

Standard Solution: ☐ Results: _____ Filtered: ☐
Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____
Notes:

Nitrate (NO_3^--N):

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.50 mg/L(1) Concentration: _____ ppm
Program/Module: 55 Analysis Time: _____ Filtered: ☐

Standard Solution: ☐ Results: _____ Nitrite Interference Treatment: ☐ Reagent Blank Correction: ☐
Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____
Alternate forms: NO_2 _____ $NaNO_2$ _____ mg/L

Notes (1): If results are over limit use dilution method at step 3, 5ml sample 10ml DI result X3, range upto 1.5mg/L

Notes:

Nitrite (NO_2^--N): Concentration: _____ ppm
Equipment: DR-850 DR-8 _ _ Range: 0 - 0.350 mg/L Analysis Time: _____ Filtered: ☐
Program/Module: 62
Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐
Notes:

Manganese (Mn^{2+}): Concentration: _____ ppm
Equipment: DR-850 DR-8 _ _ Range: 0 - 20.0 mg/L Analysis Time: _____ Filtered: ☐
Program/Module: 525nm 41
Standard Solution: ☐ Results: _____ Digestion: ☐ Reagent Blank Correction: ☐
Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Equipment: HACH MN-5 Range: 0 - 3 mg/L
Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☐
Correct measurement units are cited in the SAMPLING DATA block: ☐
Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☐
Mulitplication is correct for each *Multiplier* table: ☐
Final calulated concentration is within the appropriate *Range Used* block: ☐
Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☐
QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☐
Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☐
Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☐

APPENDIX C

LABORATORY STANDARD OPERATING PROCEDURES AND ACCREDITATIONS

EMPIRICAL LABORATORIES, LLC

Only the Certificate of Accreditation is provided. Standard Operating Procedures were provided in the Draft Final UFP-SAP and will be provided electronically upon request.

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Scope of Accreditation For Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
1-877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	8260B	1,1,2-Trichloroethane
GC/MS	8260B	1,1,2,2-Tetrachloroethane
GC/MS	8260B	1,1,1,2-Tetrachloroethane
GC/MS	8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	8260B	1,2,3-Trichlorobenzene
GC/MS	8260B	1,2,4-Trichlorobenzene
GC/MS	8260B	1,2,3-Trichloropropane
GC/MS	8260B	1,2,4-Trimethylbenzene
GC/MS	8260B	1,3,5-Trimethylbenzene
GC/MS	8260B	1,2-Dibromoethane (EDB)
GC/MS	8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	8260B	1,2-Dichlorobenzene
GC/MS	8260B	1,2-Dichloroethane (EDC)
GC/MS	8260B	1,2-Dichloropropane
GC/MS	8260B	1,3-Dichlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,4-Dichlorobenzene
GC/MS	8260B	1,1-Dichloropropene
GC/MS	8260B	1,3-Dichloropropane
GC/MS	8260B	2,2-Dichloropropane
GC/MS	8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	8260B	Acetone
GC/MS	8260B	Benzene
GC/MS	8260B	Bromochloromethane
GC/MS	8260B	Bromodichloromethane
GC/MS	8260B	Bromobenzene
GC/MS	8260B	Bromoform
GC/MS	8260B	Bromomethane
GC/MS	8260B	n-Butylbenzene
GC/MS	8260B	sec-Butylbenzene
GC/MS	8260B	tert-Butylbenzene
GC/MS	8260B	Carbon Disulfide
GC/MS	8260B	Carbon Tetrachloride
GC/MS	8260B	Chlorobenzene
GC/MS	8260B	Chloroethane
GC/MS	8260B	Chloroform
GC/MS	8260B	Chloromethane
GC/MS	8260B	2-Chlorotoluene
GC/MS	8260B	4-Chlorotoluene
GC/MS	8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	8260B	cis-1,3-Dichloropropene
GC/MS	8260B	Cyclohexane
GC/MS	8260B	Dibromochloromethane
GC/MS	8260B	Dibromomethane
GC/MS	8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	8260B	Ethylbenzene
GC/MS	8260B	Hexachlorobutadiene
GC/MS	8260B	Isopropylbenzene (Cumene)
GC/MS	8260B	p-Isopropyltoluene
GC/MS	8260B	Methyl Acetate
GC/MS	8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	8260B	Methylcyclohexane
GC/MS	8260B	Methylene Chloride, or Dichloromethane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B	Naphthalene
GC/MS	8260B	n-Propylbenzene
GC/MS	8260B	Styrene
GC/MS	8260B	Tetrachloroethene (PCE; PERC)
GC/MS	8260B	Toluene
GC/MS	8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	8260B	trans-1,3-Dichloropropene
GC/MS	8260B	Trichloroethene (TCE)
GC/MS	8260B	Trichlorofluoromethane (CFC-11)
GC/MS	8260B	Vinyl Chloride (VC)
GC/MS	8260B	Xylenes (Total)
GC/MS	8260B	Acrolein
GC/MS	8260B	Acrylonitrile
GC/MS	8260B	Di-isopropyl ether
GC/MS	8260B	ETBE
GC/MS	8260B	Ethyl methacrylate
GC/MS	8260B	Iodomethane
GC/MS	8260B	Methyl methacrylate
GC/MS	8260B	t-Butyl alcohol
GC/MS	8260B	tert-Amyl methyl ether
GC/MS	8260B	Vinyl acetate
GC/MS	8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	8270C/D	1,2-Dichlorobenzene
GC/MS	8270C/D	1,3-Dichlorobenzene
GC/MS	8270C/D	1,4-Dichlorobenzene
GC/MS	8270C/D	2,4,5-Trichlorophenol
GC/MS	8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	8270C/D	2,4-Dimethylphenol
GC/MS	8270C/D	2,4-Dinitrophenol
GC/MS	8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	8270C/D	2,6-Dichlorophenol
GC/MS	8270C/D	2,6-Dinitrotoluene
GC/MS	8270C/D	1,2-Diphenylhydrazine
GC/MS	8270C/D	2-Chloronaphthalene
GC/MS	8270C/D	2-Chlorophenol
GC/MS	8270C/D	2-Methylnaphthalene
GC/MS	8270C/D	2-Methylphenol (o-Cresol)
GC/MS	8270C/D	2-Nitroaniline

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	2-Nitrophenol (ONP)
GC/MS	8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	8270C/D	3-Methylphenol
GC/MS	8270C/D	3-Nitroaniline
GC/MS	8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	8270C/D	4-Bromophenyl phenyl ether
GC/MS	8270C/D	4-Chloro-3-methylphenol
GC/MS	8270C/D	4-Chloroaniline
GC/MS	8270C/D	4-Chlorophenyl phenyl ether
GC/MS	8270C/D	4-Methylphenol (p-Cresol)
GC/MS	8270C/D	4-Nitroaniline (PNA)
GC/MS	8270C/D	4-Nitrophenol (PNP)
GC/MS	8270C/D	Acenaphthene
GC/MS	8270C/D	Acenaphthylene
GC/MS	8270C/D	Acetaphenone
GC/MS	8270C/D	Anthracene
GC/MS	8270C/D	Benzo(a)anthracene
GC/MS	8270C/D	Benzo(a)pyrene
GC/MS	8270C/D	Benzo(b)fluoranthene
GC/MS	8270C/D	Benzo(g,h,i)perylene
GC/MS	8270C/D	Benzo(k)fluoranthene
GC/MS	8270C/D	Benzyl alcohol
GC/MS	8270C/D	Benzoic Acid
GC/MS	8270C/D	bis(2-Chloroethoxy)methane
GC/MS	8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	8270C/D	Carbazole
GC/MS	8270C/D	Chrysene
GC/MS	8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	8270C/D	Dibenz(a,h)anthracene
GC/MS	8270C/D	Dibenzofuran (DBF)
GC/MS	8270C/D	Diethyl phthalate (DEP)
GC/MS	8270C/D	Dimethyl phthalate (DMP)
GC/MS	8270C/D	Fluoranthene
GC/MS	8270C/D	Fluorene
GC/MS	8270C/D	Hexachlorobenzene (HCB)
GC/MS	8270C/D	Hexachlorobutadiene (HCBD)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	8270C/D	Hexachloroethane (HCE)
GC/MS	8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	8270C/D	Isophorone
GC/MS	8270C/D	N-Nitrosodimethylamine
GC/MS	8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	8270C/D	Naphthalene
GC/MS	8270C/D	Nitrobenzene
GC/MS	8270C/D	Pentachlorophenol
GC/MS	8270C/D	Phenanthrene
GC/MS	8270C/D	Phenol
GC/MS	8270C/D	Pyrene
GC/MS	8270C/D	Pyridine
GC/MS	8270C/D	1,2,4-Trichlorobenzene
GC/MS	8270C/D	1,1'-Biphenyl
GC/MS	8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	8270C/D	1,4-Dioxane
GC/MS	8270C/D	1-Methylnaphthalene
GC/MS	8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	8270C/D	Aniline
GC/MS	8270C/D	Atrazine
GC/MS	8270C/D	Benzaldehyde
GC/MS	8270C/D	Benzidine
GC/MS	8270C/D	Caprolactam
GC/ECD	8081A/B	4,4'-DDD
GC/ECD	8081A/B	4,4'-DDE
GC/ECD	8081A/B	4,4'-DDT
GC/ECD	8081A/B	Aldrin
GC/ECD	8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	8081A/B	alpha-Chlordane
GC/ECD	8081A/B	beta-BHC (beta-HCH)
GC/ECD	8081A/B	delta-BHC (delta-HCH)
GC/ECD	8081A/B	Dieldrin
GC/ECD	8081A/B	Endosulfan I
GC/ECD	8081A/B	Endosulfan II
GC/ECD	8081A/B	Endosulfan sulfate
GC/ECD	8081A/B	Endrin

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	8081A/B	Endrin aldehyde
GC/ECD	8081A/B	Endrin ketone
GC/ECD	8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	8081A/B	gamma-Chlordane
GC/ECD	8081A/B	Heptachlor
GC/ECD	8081A/B	Heptachlor epoxide
GC/ECD	8081A/B	Methoxychlor
GC/ECD	8081A/B	Chlordane
GC/ECD	8081A/B	Toxaphene
GC/ECD	8082 /A	Aroclor-1016
GC/ECD	8082 /A	Aroclor-1221
GC/ECD	8082 /A	Aroclor-1232
GC/ECD	8082 /A	Aroclor-1242
GC/ECD	8082 /A	Aroclor-1248
GC/ECD	8082 /A	Aroclor-1254
GC/ECD	8082 /A	Aroclor-1260
GC/ECD	8151A	2,4,5-T
GC/ECD	8151A	2,4,5-TP (Silvex)
GC/ECD	8151A	2,4-D
GC/ECD	8151A	2,4-DB
GC/ECD	8151A	Dalapon
GC/ECD	8151A	Dicamba
GC/ECD	8151A	Dichlorprop
GC/ECD	8151A	Dinoseb
GC/ECD	8151A	MCPA
GC/ECD	8151A	MCPP (Mecoprop)
HPLC/UV	8330A	1,3,5-Trinitrobenzene
HPLC/UV	8330A	1,3-Dinitrobenzene
HPLC/UV	8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	8330A	2,6-Dinitrotoluene
HPLC/UV	8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	8330A	2-Nitrotoluene (ONT)
HPLC/UV	8330A	3-Nitrotoluene
HPLC/UV	8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	8330A	4-Nitrotoluene (PNT)
HPLC/UV	8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	8330A	Nitroglycerin

Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC/UV	8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	8330A	3,5-Dinitroaniline
HPLC/UV	8330A	PETN
GC/FID	8015B	TPH DRO
GC/FID	8015B	TPH GRO
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/ECD	8011	1,2-Dibromoethane (EDB)
GC/ECD	8011	1,2-Dibromo-3-chloropropane (DBCP)
HPLC/MS	6850	Perchlorate
ICP	6010B/C	Aluminum
ICP	6010B/C	Antimony
ICP	6010B/C	Arsenic
ICP	6010B/C	Barium
ICP	6010B/C	Beryllium
ICP	6010B/C	Cadmium
ICP	6010B/C	Calcium
ICP	6010B/C	Chromium, total
ICP	6010B/C	Cobalt
ICP	6010B/C	Copper
ICP	6010B/C	Iron
ICP	6010B/C	Lead
ICP	6010B/C	Magnesium
ICP	6010B/C	Manganese
CVAA	7470A	Mercury
ICP	6010B/C	Nickel
ICP	6010B/C	Potassium
ICP	6010B/C	Selenium
ICP	6010B/C	Silver
ICP	6010B/C	Sodium
ICP	6010B/C	Thallium
ICP	6010B/C	Vanadium
ICP	6010B/C	Zinc
ICP	6010B/C	Molybdenum
ICP	6010B/C	Tin
ICP	6010B/C	Titanium
IC	300.0	Chloride
IC	300.0	Fluoride

Non-Potable Water		
Technology	**Method**	**Analyte**
IC	300.0	Nitrate
IC	300.0	Nitrite
IC	300.0	Sulfate
IC	9056A	Chloride
IC	9056A	Fluoride
IC	9056A	Nitrate
IC	9056A	Nitrite
IC	9056A	Sulfate
Titration	SM 2320B 20th ed.	Alkalinity
ISE	SM 4500 B, D, 20th ed.	Ammonia
UV/Vis	7196A	Hexavalent Chromium
Colorimetric	353.2	Nitrate/Nitrite
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	SM 4500 S-2CF, 20th edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20th edition	Total Phosphorus
UV/Vis	SM 4500 PE, 20th edition	Ortho-Phosphorus
TOC	9060A/SM5310C, 20th edition	Total Organic Carbon
Gravimetric	SM 2540C, 20th edition	TDS
Colorimetric	9012A/B	Cyanide
Physical	1010A	Ignitability
Physical	9095B	Paint Filter
Probe	9040B/C	pH
Preparation	**Method**	**Type**
Preparation	1311	TCLP
Preparation	3005A	Metals digestion
Preparation	3010A	Metals digestion
Preparation	3510C	Organics Liquid Extraction
Preparation	5030A/B	Purge and Trap Water

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	8260B	1,1,2-Trichloroethane
GC/MS	8260B	1,1,2,2-Tetrachloroethane
GC/MS	8260B	1,1,1,2-Tetrachloroethane
GC/MS	8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	8260B	1,2,3-Trichlorobenzene
GC/MS	8260B	1,2,4-Trichlorobenzene
GC/MS	8260B	1,2,3-Trichloropropane
GC/MS	8260B	1,2,4-Trimethylbenzene
GC/MS	8260B	1,3,5-Trimethylbenzene
GC/MS	8260B	1,2-Dibromoethane (EDB)
GC/MS	8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	8260B	1,2-Dichlorobenzene
GC/MS	8260B	1,2-Dichloroethane (EDC)
GC/MS	8260B	1,2-Dichloropropane
GC/MS	8260B	1,3-Dichlorobenzene
GC/MS	8260B	1,4-Dichlorobenzene
GC/MS	8260B	1,1-Dichloropropene
GC/MS	8260B	1,3-Dichloropropane
GC/MS	8260B	2,2-Dichloropropane
GC/MS	8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	8260B	Acetone
GC/MS	8260B	Benzene
GC/MS	8260B	Bromochloromethane
GC/MS	8260B	Bromodichloromethane
GC/MS	8260B	Bromobenzene
GC/MS	8260B	Bromoform
GC/MS	8260B	Bromomethane
GC/MS	8260B	n-Butylbenzene
GC/MS	8260B	sec-Butylbenzene
GC/MS	8260B	tert-Butylbenzene
GC/MS	8260B	Carbon Disulfide
GC/MS	8260B	Carbon Tetrachloride
GC/MS	8260B	Chlorobenzene
GC/MS	8260B	Chloroethane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8260B	Chloroform
GC/MS	8260B	Chloromethane
GC/MS	8260B	2-Chlorotoluene
GC/MS	8260B	4-Chlorotoluene
GC/MS	8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	8260B	cis-1,3-Dichloropropene
GC/MS	8260B	Cyclohexane
GC/MS	8260B	Dibromochloromethane
GC/MS	8260B	Dibromomethane
GC/MS	8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	8260B	Ethylbenzene
GC/MS	8260B	Hexachlorobutadiene
GC/MS	8260B	Isopropylbenzene (Cumene)
GC/MS	8260B	p-Isopropyltoluene
GC/MS	8260B	Methyl Acetate
GC/MS	8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	8260B	Methylcyclohexane
GC/MS	8260B	Methylene Chloride, or Dichloromethane
GC/MS	8260B	Naphthalene
GC/MS	8260B	n-Propylbenzene
GC/MS	8260B	Styrene
GC/MS	8260B	Tetrachloroethene (PCE; PERC)
GC/MS	8260B	Toluene
GC/MS	8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	8260B	trans-1,3-Dichloropropene
GC/MS	8260B	Trichloroethene (TCE)
GC/MS	8260B	Trichlorofluoromethane (CFC-11)
GC/MS	8260B	Vinyl Chloride (VC)
GC/MS	8260B	Xylenes (Total)
GC/MS	8260B	Acrolein
GC/MS	8260B	Acrylonitrile
GC/MS	8260B	Ethyl methacrylate
GC/MS	8260B	Iodomethane
GC/MS	8260B	Methyl methacrylate
GC/MS	8260B	Vinyl acetate
GC/MS	8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	8270C/D	1,2-Dichlorobenzene
GC/MS	8270C/D	1,3-Dichlorobenzene
GC/MS	8270C/D	1,4-Dichlorobenzene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	2,4,5-Trichlorophenol
GC/MS	8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	8270C/D	2,4-Dimethylphenol
GC/MS	8270C/D	2,4-Dinitrophenol
GC/MS	8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	8270C/D	2,6-Dichlorophenol
GC/MS	8270C/D	2,6-Dinitrotoluene
GC/MS	8270C/D	1,2-Diphenylhydrazine
GC/MS	8270C/D	2-Chloronaphthalene
GC/MS	8270C/D	2-Chlorophenol
GC/MS	8270C/D	2-Methylnaphthalene
GC/MS	8270C/D	2-Methylphenol (o-Cresol)
GC/MS	8270C/D	2-Nitroaniline
GC/MS	8270C/D	2-Nitrophenol (ONP)
GC/MS	8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	8270C/D	3-Methylphenol
GC/MS	8270C/D	3-Nitroaniline
GC/MS	8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	8270C/D	4-Bromophenyl phenyl ether
GC/MS	8270C/D	4-Chloro-3-methylphenol
GC/MS	8270C/D	4-Chloroaniline
GC/MS	8270C/D	4-Chlorophenyl phenyl ether
GC/MS	8270C/D	4-Methylphenol (p-Cresol)
GC/MS	8270C/D	4-Nitroaniline (PNA)
GC/MS	8270C/D	4-Nitrophenol (PNP)
GC/MS	8270C/D	Acenaphthene
GC/MS	8270C/D	Acenaphthylene
GC/MS	8270C/D	Acetaphenone
GC/MS	8270C/D	Anthracene
GC/MS	8270C/D	Benzo(a)anthracene
GC/MS	8270C/D	Benzo(a)pyrene
GC/MS	8270C/D	Benzo(b)fluoranthene
GC/MS	8270C/D	Benzo(g,h,i)perylene
GC/MS	8270C/D	Benzo(k)fluoranthene
GC/MS	8270C/D	Benzyl alcohol
GC/MS	8270C/D	Benzoic Acid
GC/MS	8270C/D	bis(2-Chloroethoxy)methane
GC/MS	8270C/D	bis(2-Chloroethyl)ether (BCEE)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	8270C/D	Carbazole
GC/MS	8270C/D	Chrysene
GC/MS	8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	8270C/D	Dibenz(a,h)anthracene
GC/MS	8270C/D	Dibenzofuran (DBF)
GC/MS	8270C/D	Diethyl phthalate (DEP)
GC/MS	8270C/D	Dimethyl phthalate (DMP)
GC/MS	8270C/D	Fluoranthene
GC/MS	8270C/D	Fluorene
GC/MS	8270C/D	Hexachlorobenzene (HCB)
GC/MS	8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	8270C/D	Hexachloroethane (HCE)
GC/MS	8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	8270C/D	Isophorone
GC/MS	8270C/D	N-Nitrosodimethylamine
GC/MS	8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	8270C/D	Naphthalene
GC/MS	8270C/D	Nitrobenzene
GC/MS	8270C/D	Pentachlorophenol
GC/MS	8270C/D	Phenanthrene
GC/MS	8270C/D	Phenol
GC/MS	8270C/D	Pyrene
GC/MS	8270C/D	Pyridine
GC/MS	8270C/D	1,2,4-Trichlorobenzene
GC/MS	8270C/D	1,1'-Biphenyl
GC/MS	8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	8270C/D	1,4-Dioxane
GC/MS	8270C/D	1-Methylnaphthalene
GC/MS	8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	8270C/D	Aniline
GC/MS	8270C/D	Atrazine
GC/MS	8270C/D	Benzaldehyde
GC/MS	8270C/D	Benzidine
GC/MS	8270C/D	Caprolactam

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/ECD	8081A/B	4,4'-DDD
GC/ECD	8081A/B	4,4'-DDE
GC/ECD	8081A/B	4,4'-DDT
GC/ECD	8081A/B	Aldrin
GC/ECD	8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	8081A/B	alpha-Chlordane
GC/ECD	8081A/B	beta-BHC (beta-HCH)
GC/ECD	8081A/B	delta-BHC (delta-HCH)
GC/ECD	8081A/B	Dieldrin
GC/ECD	8081A/B	Endosulfan I
GC/ECD	8081A/B	Endosulfan II
GC/ECD	8081A/B	Endosulfan sulfate
GC/ECD	8081A/B	Endrin
GC/ECD	8081A/B	Endrin aldehyde
GC/ECD	8081A/B	Endrin ketone
GC/ECD	8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	8081A/B	gamma-Chlordane
GC/ECD	8081A/B	Heptachlor
GC/ECD	8081A/B	Heptachlor epoxide
GC/ECD	8081A/B	Methoxychlor
GC/ECD	8081A/B	Chlordane
GC/ECD	8081A/B	Toxaphene
GC/ECD	8082 /A	Aroclor-1016
GC/ECD	8082 /A	Aroclor-1221
GC/ECD	8082 /A	Aroclor-1232
GC/ECD	8082 /A	Aroclor-1242
GC/ECD	8082 /A	Aroclor-1248
GC/ECD	8082 /A	Aroclor-1254
GC/ECD	8082 /A	Aroclor-1260
GC/ECD	8151A	2,4,5-T
GC/ECD	8151A	2,4,5-TP (Silvex)
GC/ECD	8151A	2,4-D
GC/ECD	8151A	2,4-DB
GC/ECD	8151A	Dalapon
GC/ECD	8151A	Dicamba
GC/ECD	8151A	Dichlorprop
GC/ECD	8151A	Dinoseb
GC/ECD	8151A	MCPA
GC/ECD	8151A	MCPP (Mecoprop)

Solid and Chemical Materials

Technology	Method	Analyte
HPLC/UV	8330A	1,3,5-Trinitrobenzene
HPLC/UV	8330A	1,3-Dinitrobenzene
HPLC/UV	8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	8330A	2,6-Dinitrotoluene
HPLC/UV	8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	8330A	2-Nitrotoluene (ONT)
HPLC/UV	8330A	3-Nitrotoluene
HPLC/UV	8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	8330A	4-Nitrotoluene (PNT)
HPLC/UV	8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	8330A	Nitroglycerin
HPLC/UV	8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	8330A	PETN
GC/FID	8015B	TPH DRO
GC/FID	8015B	TPH GRO
HPLC/MS	6850	Perchlorate
ICP	6010B/C	Aluminum
ICP	6010B/C	Antimony
ICP	6010B/C	Arsenic
ICP	6010B/C	Barium
ICP	6010B/C	Beryllium
ICP	6010B/C	Cadmium
ICP	6010B/C	Calcium
ICP	6010B/C	Chromium, total
ICP	6010B/C	Cobalt
ICP	6010B/C	Copper
ICP	6010B/C	Iron
ICP	6010B/C	Lead
ICP	6010B/C	Magnesium
ICP	6010B/C	Manganese
CVAA	7471A/B	Mercury
ICP	6010B/C	Nickel
ICP	6010B/C	Potassium
ICP	6010B/C	Selenium
ICP	6010B/C	Silver
ICP	6010B/C	Sodium
ICP	6010B/C	Thallium

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	6010B/C	Vanadium
ICP	6010B/C	Zinc
ICP	6010B/C	Molybdenum
ICP	6010B/C	Tin
ICP	6010B/C	Titanium
UV/Vis	7196A	Hexavalent Chromium
TOC	Lloyd Kahn	Total Organic Carbon
Colorimetric	9012A/B	Cyanide
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	9034	Sulfide
Probe	9045D	pH
Preparation	**Method**	**Type**
Preparation	1311	TCLP
Preparation	1312	SPLP
Preparation	NJ Modified 3060A	Hexavalent Chromium
Preparation	3050B	Metals Digestion
Preparation	3546	Organics Microwave Extraction
Preparation	3541	Organics Soxhlet Extraction
Preparation	3550B	Organics Sonication
Preparation	SM 2540B 20th edition	Percent Solids (Percent Moisture)
Preparation	5035 /A	Purge and Trap Solid

Notes:

1) This laboratory offers commercial testing service.

Approved By: _____ Date: November 30, 2009

R. Douglas Leonard
Chief Technical Officer

Issued: 11/30/09

MICROSEEPS, INCORPORATED

Only the Certificate of Accreditation is provided. Standard Operating Procedures were provided in the Draft Final UFP-SAP and will be provided electronically upon request.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

OFFICE OF FIELD OPERATIONS

BUREAU OF LABORATORIES

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Certifies that

02-00538
MICROSEEPS INCORPORATED
220 WILLIAM PITT WAY
PITTSBURGH, PA 15238-1328

Having duly met the requirement of
The Act of June 29, 2002 (P.L. 596, No. 90)
dealing with Environmental Laboratory Accreditation
(27 Pa. C.S. §§4101-4113) and the
National Environmental Laboratory Accreditation Conference Standard

is hereby approved as an

Accredited Laboratory

As more fully described in the attached Scope of Accreditation

Expiration Date: **11/30/2012**
Certificate Number: **009**

Continued accreditation status depends on successful ongoing participation in the Program
Certificate not transferable Surrender upon revocation
To be conspicuously displayed at the Laboratory
Not valid unless accompanied by a valid Scope of Accreditation
Shall not be used to imply endorsement by the Commonwealth of Pennsylvania
Customers are urged to verify the laboratory's current accreditation status
PA DEP is a NELAP recognized accreditation body

Aaren S. Alger, Chief
Laboratory Accreditation Program
Bureau of Laboratories

1500-FM-LAB0016 Rev. 8/2009

Laboratory Scope of Accreditation

Attachment to Certificate of Accreditation 009, expiration date November 30, 2012. This listing of accredited analytes should be used only when associated with a valid certificate of accreditation.

State Laboratory ID: 2-00538 **EPA Lab Code: PA00076** **(412) 826-5245**

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Non-Potable Water

Method	Analyte	Accreditation Type	Primary	Effective Date
EPA 5030B	Aqueous-phase purge-and-trap	NELAP	PA	1/6/2006
EPA 624	1,1,1-Trichloroethane	NELAP	PA	1/6/2006
EPA 624	1,1,2,2-Tetrachloroethane	NELAP	PA	1/6/2006
EPA 624	1,1,2-Trichloroethane	NELAP	PA	1/6/2006
EPA 624	1,1-Dichloroethane	NELAP	PA	1/6/2006
EPA 624	1,1-Dichloroethene (1,1-Dichloroethylene)	NELAP	PA	1/6/2006
EPA 624	1,2-Dichlorobenzene (o-Dichlorobenzene)	NELAP	PA	1/6/2006
EPA 624	1,2-Dichloroethane	NELAP	PA	1/6/2006
EPA 624	1,2-Dichloropropane	NELAP	PA	1/6/2006
EPA 624	1,3-Dichlorobenzene (m-Dichlorobenzene)	NELAP	PA	1/6/2006
EPA 624	1,4-Dichlorobenzene (p-Dichlorobenzene)	NELAP	PA	1/6/2006
EPA 624	2-Chloroethyl vinyl ether	NELAP	PA	1/6/2006
EPA 624	Acrolein (Propenal)	NELAP	PA	1/6/2006
EPA 624	Acrylonitrile	NELAP	PA	1/6/2006
EPA 624	Benzene	NELAP	PA	1/6/2006
EPA 624	Bromodichloromethane	NELAP	PA	1/6/2006
EPA 624	Bromoform	NELAP	PA	1/6/2006
EPA 624	Carbon tetrachloride	NELAP	PA	1/6/2006
EPA 624	Chlorobenzene	NELAP	PA	1/6/2006
EPA 624	Chloroethane	NELAP	PA	1/6/2006
EPA 624	Chloroform	NELAP	PA	1/6/2006
EPA 624	Dibromochloromethane	NELAP	PA	1/6/2006
EPA 624	Ethylbenzene	NELAP	PA	1/6/2006
EPA 624	Methyl bromide (Bromomethane)	NELAP	PA	1/6/2006
EPA 624	Methyl chloride (Chloromethane)	NELAP	PA	1/6/2006
EPA 624	Methylene chloride (Dichloromethane)	NELAP	PA	1/6/2006
EPA 624	Tetrachloroethene (PCE, Perchloroethylene)	NELAP	PA	9/24/2007
EPA 624	Toluene	NELAP	PA	1/6/2006
EPA 624	Trichloroethene (TCE, Trichloroethylene)	NELAP	PA	2/8/2008
EPA 624	Trichlorofluoromethane (Freon 11)	NELAP	PA	1/6/2006
EPA 624	Vinyl chloride (Chloroethene)	NELAP	PA	1/6/2006
EPA 624	Xylenes, total	NELAP	PA	1/6/2006
EPA 624	cis-1,3-Dichloropropene	NELAP	PA	1/6/2006
EPA 624	trans-1,2-Dichloroethene	NELAP	PA	1/6/2006
EPA 624	trans-1,3-Dichloropropene	NELAP	PA	1/6/2006
EPA 7199 Modified	Divalent manganese	NELAP	PA	11/15/2010

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State Laboratory ID: 2-00538 **EPA Lab Code: PA00076** **(412) 826-5245**

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Non-Potable Water

Method	Analyte	Accreditation Type	Primary	Effective Date
EPA 7199 Modified	Ferric iron	NELAP	PA	11/15/2010
EPA 7199 Modified	Ferrous iron	NELAP	PA	11/15/2010
EPA 8260	1,1,1,2-Tetrachloroethane	NELAP	PA	1/6/2006
EPA 8260	1,1,1-Trichloroethane	NELAP	PA	1/6/2006
EPA 8260	1,1,2,2-Tetrachloroethane	NELAP	PA	1/6/2006
EPA 8260	1,1,2-Trichloroethane	NELAP	PA	1/6/2006
EPA 8260	1,1-Dichloroethane	NELAP	PA	1/6/2006
EPA 8260	1,1-Dichloroethene (1,1-Dichloroethylene)	NELAP	PA	1/6/2006
EPA 8260	1,1-Dichloropropene	NELAP	PA	1/6/2006
EPA 8260	1,2,3-Trichlorobenzene	NELAP	PA	1/6/2006
EPA 8260	1,2,3-Trichloropropane (1,2,3-TCP)	NELAP	PA	1/6/2006
EPA 8260	1,2,4-Trichlorobenzene	NELAP	PA	1/6/2006
EPA 8260	1,2,4-Trimethylbenzene	NELAP	PA	1/6/2006
EPA 8260	1,2-Dibromo-3-chloropropane (DBCP, Dibromochloropropane)	NELAP	PA	2/8/2008
EPA 8260	1,2-Dibromoethane (EDB, Ethylene dibromide)	NELAP	PA	9/26/2007
EPA 8260	1,2-Dichlorobenzene (o-Dichlorobenzene)	NELAP	PA	9/26/2007
EPA 8260	1,2-Dichloroethane	NELAP	PA	1/6/2006
EPA 8260	1,2-Dichloropropane	NELAP	PA	1/6/2006
EPA 8260	1,3,5-Trimethylbenzene	NELAP	PA	1/6/2006
EPA 8260	1,3-Dichlorobenzene (m-Dichlorobenzene)	NELAP	PA	1/6/2006
EPA 8260	1,3-Dichloropropane	NELAP	PA	1/6/2006
EPA 8260	1,4-Dichlorobenzene (p-Dichlorobenzene)	NELAP	PA	1/6/2006
EPA 8260	2,2-Dichloropropane	NELAP	PA	1/6/2006
EPA 8260	2-Butanone (Methyl ethyl ketone, MEK)	NELAP	PA	9/26/2007
EPA 8260	2-Chlorotoluene	NELAP	PA	1/6/2006
EPA 8260	2-Hexanone	NELAP	PA	9/26/2007
EPA 8260	4-Chlorotoluene	NELAP	PA	1/6/2006
EPA 8260	4-Methyl-2-pentanone (MIBK)	NELAP	PA	1/6/2006
EPA 8260	Acetone	NELAP	PA	1/6/2006
EPA 8260	Benzene	NELAP	PA	1/6/2006
EPA 8260	Bromobenzene	NELAP	PA	1/6/2006
EPA 8260	Bromochloromethane	NELAP	PA	1/6/2006
EPA 8260	Bromodichloromethane	NELAP	PA	1/9/2009
EPA 8260	Bromoform	NELAP	PA	1/6/2006
EPA 8260	Carbon disulfide	NELAP	PA	1/6/2006
EPA 8260	Carbon tetrachloride	NELAP	PA	1/6/2006

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State Laboratory ID: 2-00538 **EPA Lab Code:** PA00076 (412) 826-5245

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Non-Potable Water

Method	Analyte	Accreditation Type	Primary	Effective Date
EPA 8260	Chlorobenzene	NELAP	PA	1/6/2006
EPA 8260	Chloroethane	NELAP	PA	1/6/2006
EPA 8260	Chloroform	NELAP	PA	1/6/2006
EPA 8260	Dibromochloromethane	NELAP	PA	1/6/2006
EPA 8260	Dibromochloropropane (1,2-Dibromo-3-chloropropane, DBCP)	NELAP	PA	8/16/2006
EPA 8260	Dibromomethane	NELAP	PA	1/6/2006
EPA 8260	Dichlorodifluoromethane (Freon 12)	NELAP	PA	1/6/2006
EPA 8260	Ethanol	NELAP	PA	9/26/2007
EPA 8260	Ethylbenzene	NELAP	PA	1/6/2006
EPA 8260	Hexachlorobutadiene (1,3-Hexachlorobutadiene)	NELAP	PA	1/6/2006
EPA 8260	Isopropylbenzene (Cumene)	NELAP	PA	1/6/2006
EPA 8260	Methyl bromide (Bromomethane)	NELAP	PA	1/6/2006
EPA 8260	Methyl chloride (Chloromethane)	NELAP	PA	1/6/2006
EPA 8260	Methyl tert-butyl ether (MTBE)	NELAP	PA	1/6/2006
EPA 8260	Methylene chloride (Dichloromethane)	NELAP	PA	1/6/2006
EPA 8260	Naphthalene	NELAP	PA	1/6/2006
EPA 8260	Styrene	NELAP	PA	1/6/2006
EPA 8260	Tetrachloroethene (PCE, Perchloroethylene)	NELAP	PA	9/24/2007
EPA 8260	Toluene	NELAP	PA	1/6/2006
EPA 8260	Trichloroethene (TCE, Trichloroethylene)	NELAP	PA	1/6/2006
EPA 8260	Trichlorofluoromethane (Freon 11)	NELAP	PA	1/6/2006
EPA 8260	Vinyl chloride (Chloroethene)	NELAP	PA	1/6/2006
EPA 8260	Xylenes, total	NELAP	PA	1/6/2006
EPA 8260	cis-1,2-Dichloroethene	NELAP	PA	1/6/2006
EPA 8260	cis-1,3-Dichloropropene	NELAP	PA	1/6/2006
EPA 8260	n-Butylbenzene	NELAP	PA	1/6/2006
EPA 8260	n-Propylbenzene	NELAP	PA	1/6/2006
EPA 8260	sec-Butylbenzene	NELAP	PA	1/6/2006
EPA 8260	tert-Butyl alcohol (2-Methyl-2-propanol)	NELAP	PA	9/26/2007
EPA 8260	tert-Butylbenzene	NELAP	PA	1/6/2006
EPA 8260	trans-1,2-Dichloroethene	NELAP	PA	1/6/2006
EPA 8260	trans-1,3-Dichloropropene	NELAP	PA	1/6/2006
EPA 8260-Extended	Methyl isobutyl ketone (MIBK, 4-Methyl-2-pentanone)	NELAP	PA	11/7/2005
EPA 9040B	pH	NELAP	PA	3/20/2009
EPA 9056A	Chloride	NELAP	PA	4/21/2009

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State Laboratory ID: 2-00538 **EPA Lab Code: PA00076** **(412) 826-5245**

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Non-Potable Water

Method	Analyte	Accreditation Type	Primary	Effective Date
EPA 9056A	Nitrate	NELAP	PA	1/6/2006
EPA 9056A	Nitrite	NELAP	PA	1/6/2006
EPA 9056A	Sulfate	NELAP	PA	1/6/2006
EPA 9060	Total organic carbon (TOC)	NELAP	PA	11/15/2010
Microseeps SOP- AM20Gax	Carbon dioxide	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Carbon monoxide	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Ethane	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Ethene	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Hydrogen	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Isobutane (2-Methylpropane)	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Methane	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Oxygen	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Propane	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Propene	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	n-Butane	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Inorganic carbon, total	NELAP	PA	1/6/2006
Microseeps SOP- AM20Gax	Acetylene (Ethyne)	NELAP	PA	1/6/2006
Microseeps SOP- AM21G	Acetic acid (Ethanoic acid)	NELAP	PA	3/20/2009
Microseeps SOP- AM21G	Lactic acid	NELAP	PA	3/20/2009
Microseeps SOP- AM21G	Butyric acid	NELAP	PA	3/20/2009
Microseeps SOP- AM21G	Propionic acid	NELAP	PA	3/20/2009
Microseeps SOP- AM21G	Pyruvic acid	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Total petroleum hydrocarbons (TPH)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	n-Decane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	n-Dodecane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	n-Hexadecane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,1,1-Trichloroethane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,1,2,2-Tetrachloroethane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,1,2-Trichloroethane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,1-Dichloroethane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,1-Dichloroethene (1,1-Dichloroethylene)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,2,3-Trichlorobenzene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,2,4-Trichlorobenzene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,2,4-Trimethylbenzene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,2-Dichlorobenzene (o-Dichlorobenzene)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,2-Dichloroethane	NELAP	PA	1/6/2006

Attachment to Certificate of Accreditation 009, expiration date November 30, 2012. This listing of accredited analytes should be used only when associated with a valid certificate of accreditation.

State Laboratory ID: 2-00538 **EPA Lab Code: PA00076** **(412) 826-5245**

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Non-Potable Water

Method	Analyte	Accreditation Type	Primary	Effective Date
Microseeps SOP-AM 4 02	1,2-Dichloropropane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,3,5-Trimethylbenzene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,3-Dichlorobenzene (m-Dichlorobenzene)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	1,4-Dichlorobenzene (p-Dichlorobenzene)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	2-Butanone (Methyl ethyl ketone, MEK)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	2-Chloroethyl vinyl ether	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	2-Hexanone	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	2-Propanol (Isopropyl alcohol)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	4-Methyl-2-pentanone (MIBK)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Acetone	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Benzene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Bromodichloromethane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Bromoform	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Carbon tetrachloride	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Chlorobenzene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Chloroethane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Chloroform	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Dibromochloromethane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Dichlorodifluoromethane (Freon 12)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Ethylbenzene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Isopropylbenzene (Cumene)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Methyl bromide (Bromomethane)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Methyl chloride (Chloromethane)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Methyl tert-butyl ether (MTBE)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Methylene chloride (Dichloromethane)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Naphthalene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Styrene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Tetrachloroethene (PCE, Perchloroethylene)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Toluene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Trichloroethene (TCE, Trichloroethylene)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Trichlorofluoromethane (Freon 11)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Vinyl chloride (Chloroethene)	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	Xylenes, total	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	cis-1,2-Dichloroethene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	cis-1,3-Dichloropropene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	n-Heptane	NELAP	PA	1/6/2006

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Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Non-Potable Water

Method	Analyte	Accreditation Type	Primary	Effective Date
Microseeps SOP-AM 4 02	n-Hexane	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	trans-1,2-Dichloroethene	NELAP	PA	1/6/2006
Microseeps SOP-AM 4 02	trans-1,3-Dichloropropene	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Acetic acid (Ethanoic acid)	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Hydroxy-isobutyric acid (HIBA)	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Isohexanoic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Lactic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	n-Hexanoic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Butyric acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Isopentanoic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Propionic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Pyruvic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	n-Pentanoic acid	NELAP	PA	1/6/2006
Microseeps SOP-GCMS3	BTEX (Benzene, toluene, ethylbenzene, and xylenes)	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	Ethanol	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	Ethyl tert-butyl ether (ETBE)	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	Isopropylbenzene (Cumene)	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	Methyl tert-butyl ether (MTBE)	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	Naphthalene	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	tert-Amyl alcohol (2-Methyl-2-butanol)	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	tert-Amyl ethyl ether (TAEE)	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	tert-Amyl methyl ether (TAME)	NELAP	PA	11/27/2007
Microseeps SOP-GCMS3	tert-Butyl alcohol (2-Methyl-2-propanol)	NELAP	PA	11/27/2007
Microseeps SOP-PM 01C	Carbon dioxide	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Ethane	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Ethene	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Isobutane (2-Methylpropane)	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Methane	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Nitrogen	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Oxygen	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Propane	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Propene	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	n-Butane	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Inorganic carbon, total	NELAP	PA	1/6/2006
Microseeps SOP-PM 01C	Acetylene (Ethyne)	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	Carbon dioxide	NELAP	PA	1/6/2006

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State Laboratory ID: 2-00538 **EPA Lab Code: PA00076** **(412) 826-5245**

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Non-Potable Water

Method	Analyte	Accreditation Type	Primary	Effective Date
Microseeps SOP-SM 9	Ethane	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	Ethene	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	Hydrogen	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	Isobutane (2-Methylpropane)	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	Nitrogen	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	Oxygen	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	Propane	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	Propene	NELAP	PA	1/6/2006
Microseeps SOP-SM 9	n-Butane	NELAP	PA	1/6/2006
RSK-175	Ethane	NELAP	PA	3/20/2009
RSK-175	Ethene	NELAP	PA	3/20/2009
RSK-175	Methane	NELAP	PA	3/20/2009
RSK-175	Propane	NELAP	PA	3/20/2009
SM 2320 B	Alkalinity as CaCO3	NELAP	PA	12/7/2004
SM 4500-H+ B	pH	NELAP	PA	3/20/2009
SM 4500-S F	Sulfide	NELAP	PA	5/10/2007
SM 5310 C	Total organic carbon (TOC)	NELAP	PA	11/15/2010

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State Laboratory ID: 2-00538 **EPA Lab Code: PA00076** **(412) 826-5245**

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Solid and Chemical Materials

Method	Analyte	Accreditation Type	Primary	Effective Date
EPA 5035	Closed-system purge-and-trap (bisulfate option)	NELAP	PA	1/6/2006
EPA 5035	Closed-system purge-and-trap (methanol option)	NELAP	PA	1/6/2006
EPA 8260	1,1,1,2-Tetrachloroethane	NELAP	PA	11/7/2005
EPA 8260	1,1,1-Trichloroethane	NELAP	PA	12/7/2004
EPA 8260	1,1,2,2-Tetrachloroethane	NELAP	PA	12/7/2004
EPA 8260	1,1,2-Trichloroethane	NELAP	PA	12/7/2004
EPA 8260	1,1-Dichloroethane	NELAP	PA	12/7/2004
EPA 8260	1,1-Dichloroethene (1,1-Dichloroethylene)	NELAP	PA	12/7/2004
EPA 8260	1,2,3-Trichlorobenzene	NELAP	PA	11/7/2005
EPA 8260	1,2,3-Trichloropropane (1,2,3-TCP)	NELAP	PA	11/7/2005
EPA 8260	1,2,4-Trichlorobenzene	NELAP	PA	11/7/2005
EPA 8260	1,2,4-Trimethylbenzene	NELAP	PA	11/7/2005
EPA 8260	1,2-Dibromo-3-chloropropane (DBCP, Dibromochloropropane)	NELAP	PA	2/8/2008
EPA 8260	1,2-Dibromoethane (EDB, Ethylene dibromide)	NELAP	PA	12/7/2004
EPA 8260	1,2-Dichlorobenzene (o-Dichlorobenzene)	NELAP	PA	11/7/2005
EPA 8260	1,2-Dichloroethane	NELAP	PA	12/7/2004
EPA 8260	1,2-Dichloropropane	NELAP	PA	12/7/2004
EPA 8260	1,3-Dichlorobenzene (m-Dichlorobenzene)	NELAP	PA	11/7/2005
EPA 8260	1,3-Dichloropropane	NELAP	PA	11/7/2005
EPA 8260	1,4-Dichlorobenzene (p-Dichlorobenzene)	NELAP	PA	11/7/2005
EPA 8260	2,2-Dichloropropane	NELAP	PA	11/7/2005
EPA 8260	2-Chlorotoluene	NELAP	PA	11/7/2005
EPA 8260	2-Hexanone	NELAP	PA	11/7/2005
EPA 8260	4-Chlorotoluene	NELAP	PA	11/7/2005
EPA 8260	4-Methyl-2-pentanone (MIBK)	NELAP	PA	12/7/2004
EPA 8260	Acetone	NELAP	PA	12/7/2004
EPA 8260	Benzene	NELAP	PA	12/7/2004
EPA 8260	Bromobenzene	NELAP	PA	11/7/2005
EPA 8260	Bromochloromethane	NELAP	PA	11/7/2005
EPA 8260	Bromodichloromethane	NELAP	PA	12/7/2004
EPA 8260	Bromoform	NELAP	PA	12/7/2004
EPA 8260	Carbon disulfide	NELAP	PA	12/7/2004
EPA 8260	Carbon tetrachloride	NELAP	PA	12/7/2004
EPA 8260	Chlorobenzene	NELAP	PA	12/7/2004
EPA 8260	Chloroethane	NELAP	PA	12/7/2004
EPA 8260	Chloroform	NELAP	PA	12/7/2004

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Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Solid and Chemical Materials

Method	Analyte	Accreditation Type	Primary	Effective Date
EPA 8260	Dibromochloromethane	NELAP	PA	12/7/2004
EPA 8260	Dibromomethane	NELAP	PA	11/7/2005
EPA 8260	Dichlorodifluoromethane (Freon 12)	NELAP	PA	11/7/2005
EPA 8260	Ethylbenzene	NELAP	PA	12/7/2004
EPA 8260	Isopropylbenzene (Cumene)	NELAP	PA	12/7/2004
EPA 8260	Methyl bromide (Bromomethane)	NELAP	PA	12/7/2004
EPA 8260	Methyl chloride (Chloromethane)	NELAP	PA	12/7/2004
EPA 8260	Methyl tert-butyl ether (MTBE)	NELAP	PA	12/7/2004
EPA 8260	Methylene chloride (Dichloromethane)	NELAP	PA	12/7/2004
EPA 8260	Naphthalene	NELAP	PA	12/7/2004
EPA 8260	Styrene	NELAP	PA	12/7/2004
EPA 8260	Tetrachloroethene (PCE, Perchloroethylene)	NELAP	PA	12/7/2004
EPA 8260	Toluene	NELAP	PA	12/7/2004
EPA 8260	Trichloroethene (TCE, Trichloroethylene)	NELAP	PA	12/7/2004
EPA 8260	Trichlorofluoromethane (Freon 11)	NELAP	PA	11/7/2005
EPA 8260	Vinyl chloride (Chloroethene)	NELAP	PA	12/7/2004
EPA 8260	Xylenes, total	NELAP	PA	12/7/2004
EPA 8260	cis-1,2-Dichloroethene	NELAP	PA	12/7/2004
EPA 8260	cis-1,3-Dichloropropene	NELAP	PA	12/7/2004
EPA 8260	n-Butylbenzene	NELAP	PA	11/7/2005
EPA 8260	n-Propylbenzene	NELAP	PA	1/6/2006
EPA 8260	sec-Butylbenzene	NELAP	PA	1/6/2006
EPA 8260	tert-Butyl alcohol (2-Methyl-2-propanol)	NELAP	PA	2/8/2008
EPA 8260	tert-Butylbenzene	NELAP	PA	11/7/2005
EPA 8260	trans-1,2-Dichloroethene	NELAP	PA	12/7/2004
EPA 8260	trans-1,3-Dichloropropene	NELAP	PA	12/7/2004
EPA 8260-Extended	Methyl isobutyl ketone (MIBK, 4-Methyl-2-pentanone)	NELAP	PA	11/7/2005
EPA 9040B	pH	NELAP	PA	3/20/2009
EPA 9045	pH	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Total petroleum hydrocarbons (TPH)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	n-Decane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	n-Dodecane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	n-Hexadecane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,1,1-Trichloroethane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,1,2,2-Tetrachloroethane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,1,2-Trichloroethane	NELAP	PA	3/20/2009

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State Laboratory ID: 2-00538 **EPA Lab Code: PA00076** **(412) 826-5245**

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Solid and Chemical Materials

Method	Analyte	Accreditation Type	Primary	Effective Date
Microseeps SOP-AM 4 02	1,1-Dichloroethane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,1-Dichloroethene (1,1-Dichloroethylene)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,2,3-Trichlorobenzene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,2,4-Trichlorobenzene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,2,4-Trimethylbenzene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,2-Dichlorobenzene (o-Dichlorobenzene)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,2-Dichloroethane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,2-Dichloropropane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,3,5-Trimethylbenzene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,3-Dichlorobenzene (m-Dichlorobenzene)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	1,4-Dichlorobenzene (p-Dichlorobenzene)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	2-Butanone (Methyl ethyl ketone, MEK)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	2-Chloroethyl vinyl ether	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	2-Hexanone	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	2-Propanol (Isopropyl alcohol)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	4-Methyl-2-pentanone (MIBK)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Acetone	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Benzene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Bromodichloromethane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Bromoform	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Carbon tetrachloride	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Chlorobenzene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Chloroethane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Chloroform	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Dibromochloromethane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Dichlorodifluoromethane (Freon 12)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Ethylbenzene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Isopropylbenzene (Cumene)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Methyl bromide (Bromomethane)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Methyl chloride (Chloromethane)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Methyl tert-butyl ether (MTBE)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Methylene chloride (Dichloromethane)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Naphthalene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Styrene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Tetrachloroethene (PCE, Perchloroethylene)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4.02	Toluene	NELAP	PA	3/20/2009

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State Laboratory ID: 2-00538 **EPA Lab Code: PA00076** **(412) 826-5245**

Microseeps Inc
220 William Pitt Way
Pittsburgh, PA 15238

Program Solid and Chemical Materials

Method	Analyte	Accreditation Type	Primary	Effective Date
Microseeps SOP-AM 4 02	Trichloroethene (TCE, Trichloroethylene)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Trichlorofluoromethane (Freon 11)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Vinyl chloride (Chloroethene)	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	Xylenes, total	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	cis-1,2-Dichloroethene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	cis-1,3-Dichloropropene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	n-Heptane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	n-Hexane	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	trans-1,2-Dichloroethene	NELAP	PA	3/20/2009
Microseeps SOP-AM 4 02	trans-1,3-Dichloropropene	NELAP	PA	3/20/2009
Microseeps SOP-AM23G	Acetic acid (Ethanoic acid)	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Hydroxy-isobutyric acid (HIBA)	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Isohexanoic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Lactic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	n-Hexanoic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Butyric acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Isopentanoic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Propionic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	Pyruvic acid	NELAP	PA	1/6/2006
Microseeps SOP-AM23G	n-Pentanoic acid	NELAP	PA	1/6/2006

COLUMBIA ANALYTICAL SERVICES

Only the Certificate of Accreditation is provided. Standard Operating Procedures were provided in the Draft Final UFP-SAP and will be provided electronically upon request.

State of Florida
Department of Health, Bureau of Laboratories
This is to certify that

E87674

COLUMBIA ANALYTICAL SERVICES, INC. - NY
1565 JEFFERSON ROAD BUILDING 300, SUITE 360
ROCHESTER, NY 14623

has complied with Florida Administrative Code 64E-1,
for the examination of Environmental samples in the following categories

NON-POTABLE WATER - EXTRACTABLE ORGANICS, NON-POTABLE WATER - GENERAL CHEMISTRY, NON-POTABLE WATER - METALS, NON-POTABLE WATER - PESTICIDES-HERBICIDES-PCB'S, NON-POTABLE WATER - VOLATILE ORGANICS, SOLID AND CHEMICAL MATERIALS - EXTRACTABLE ORGANICS, SOLID AND CHEMICAL MATERIALS - GENERAL CHEMISTRY, SOLID AND CHEMICAL MATERIALS - METALS, SOLID AND CHEMICAL MATERIALS - PESTICIDES-HERBICIDES-PCB'S, SOLID AND CHEMICAL MATERIALS - VOLATILE ORGANICS

Continued certification is contingent upon successful on-going compliance with the NELAC Standards and FAC Rule 64E-1 regulations. Specific methods and analytes certified are cited on the Laboratory Scope of Accreditation for this laboratory and are on file at the Bureau of Laboratories, P. O. Box 210, Jacksonville, Florida 32231. Clients and customers are urged to verify with this agency the laboratory's certification status in Florida for particular methods and analytes.

Date Issued: July 01, 2012 Expiration Date: June 30, 2013

Max Salfinger, M.D.
Chief, Bureau of Laboratories
Florida Department of Health
DH Form 1697, 7/04
NON-TRANSFERABLE E87674-19-07/01/2012
Supersedes all previously issued certificates

Laboratory Scope of Accreditation

Attachment to Certificate #: E87674-19, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87674 **EPA Lab Code:** NY00032 **(585) 288-5380**

E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,1,1-Trichloroethane	EPA 601	Volatile Organics	NELAP	9/26/2001
1,1,1-Trichloroethane	EPA 624	Volatile Organics	NELAP	9/26/2001
1,1,1-Trichloroethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,1,2,2-Tetrachloroethane	EPA 601	Volatile Organics	NELAP	9/26/2001
1,1,2,2-Tetrachloroethane	EPA 624	Volatile Organics	NELAP	9/26/2001
1,1,2,2-Tetrachloroethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	EPA 8260	Volatile Organics	NELAP	11/30/2010
1,1,2-Trichloroethane	EPA 601	Volatile Organics	NELAP	9/26/2001
1,1,2-Trichloroethane	EPA 624	Volatile Organics	NELAP	9/26/2001
1,1,2-Trichloroethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,1-Dichloroethane	EPA 601	Volatile Organics	NELAP	9/26/2001
1,1-Dichloroethane	EPA 624	Volatile Organics	NELAP	9/26/2001
1,1-Dichloroethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,1-Dichloroethylene	EPA 601	Volatile Organics	NELAP	9/26/2001
1,1-Dichloroethylene	EPA 624	Volatile Organics	NELAP	9/26/2001
1,1-Dichloroethylene	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,1-Dichloropropene	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,2,3-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,2,3-Trichloropropane	EPA 8260	Volatile Organics	NELAP	11/20/2003
1,2,4,5-Tetrachlorobenzene	EPA 8270	Extractable Organics	NELAP	11/20/2003
1,2,4-Trichlorobenzene	EPA 625	Extractable Organics	NELAP	9/26/2001
1,2,4-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,2,4-Trichlorobenzene	EPA 8270	Extractable Organics	NELAP	9/10/2004
1,2,4-Trimethylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
1,2,4-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8011	Volatile Organics	NELAP	10/26/2007
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	7/1/2003
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8011	Volatile Organics	NELAP	10/26/2007
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	7/1/2003

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,2-Dichlorobenzene	EPA 601	Volatile Organics	NELAP	9/26/2001
1,2-Dichlorobenzene	EPA 602	Volatile Organics	NELAP	9/26/2001
1,2-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	9/26/2001
1,2-Dichlorobenzene	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,2-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
1,2-Dichloroethane	EPA 601	Volatile Organics	NELAP	9/26/2001
1,2-Dichloroethane	EPA 624	Volatile Organics	NELAP	9/26/2001
1,2-Dichloroethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,2-Dichloropropane	EPA 601	Volatile Organics	NELAP	9/26/2001
1,2-Dichloropropane	EPA 624	Volatile Organics	NELAP	9/26/2001
1,2-Dichloropropane	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,3,5-Trimethylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
1,3,5-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8270	Extractable Organics	NELAP	11/20/2003
1,3-Dichlorobenzene	EPA 601	Volatile Organics	NELAP	9/26/2001
1,3-Dichlorobenzene	EPA 602	Volatile Organics	NELAP	9/26/2001
1,3-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	9/26/2001
1,3-Dichlorobenzene	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,3-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
1,3-Dichloropropane	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,3-Dinitrobenzene (1,3-DNB)	EPA 8270	Extractable Organics	NELAP	11/20/2003
1,4-Dichlorobenzene	EPA 601	Volatile Organics	NELAP	9/26/2001
1,4-Dichlorobenzene	EPA 602	Volatile Organics	NELAP	9/26/2001
1,4-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	9/26/2001
1,4-Dichlorobenzene	EPA 8021	Volatile Organics	NELAP	9/10/2004
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/10/2004
1,4-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	7/1/2003
1,4-Dioxane (1,4-Diethyleneoxide)	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,4-Naphthoquinone	EPA 8270	Extractable Organics	NELAP	11/20/2003
1,4-Phenylenediamine	EPA 8270	Extractable Organics	NELAP	10/26/2007
1-Naphthylamine	EPA 8270	Extractable Organics	NELAP	10/26/2007

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Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
2,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	10/26/2007
2,3,4,6-Tetrachlorophenol	EPA 8270	Extractable Organics	NELAP	11/20/2003
2,4,5-T	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
2,4,5-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
2,4,6-Trichlorophenol	EPA 625	Extractable Organics	NELAP	9/26/2001
2,4,6-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
2,4-D	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
2,4-Dichlorophenol	EPA 625	Extractable Organics	NELAP	9/26/2001
2,4-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
2,4-Dimethylphenol	EPA 625	Extractable Organics	NELAP	9/26/2001
2,4-Dimethylphenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
2,4-Dinitrophenol	EPA 625	Extractable Organics	NELAP	9/26/2001
2,4-Dinitrophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
2,4-Dinitrotoluene (2,4-DNT)	EPA 625	Extractable Organics	NELAP	9/26/2001
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270	Extractable Organics	NELAP	9/10/2004
2,6-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	11/20/2003
2,6-Dinitrotoluene (2,6-DNT)	EPA 625	Extractable Organics	NELAP	9/26/2001
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270	Extractable Organics	NELAP	9/10/2004
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260	Volatile Organics	NELAP	8/25/2003
2-Chloroethyl vinyl ether	EPA 601	Volatile Organics	NELAP	9/26/2001
2-Chloroethyl vinyl ether	EPA 624	Volatile Organics	NELAP	9/26/2001
2-Chloroethyl vinyl ether	EPA 8021	Volatile Organics	NELAP	9/10/2004
2-Chloroethyl vinyl ether	EPA 8260	Volatile Organics	NELAP	9/10/2004
2-Chloronaphthalene	EPA 625	Extractable Organics	NELAP	9/26/2001
2-Chloronaphthalene	EPA 8270	Extractable Organics	NELAP	9/10/2004
2-Chlorophenol	EPA 625	Extractable Organics	NELAP	9/26/2001
2-Chlorophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
2-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	11/30/2010
2-Hexanone	EPA 8260	Volatile Organics	NELAP	11/20/2003
2-Methyl-4,6-dinitrophenol	EPA 625	Extractable Organics	NELAP	9/26/2001
2-Methyl-4,6-dinitrophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
2-Methylnaphthalene	EPA 8270	Extractable Organics	NELAP	7/1/2003
2-Methylphenol (o-Cresol)	EPA 8270	Extractable Organics	NELAP	7/1/2003
2-Naphthylamine	EPA 8270	Extractable Organics	NELAP	11/30/2010
2-Nitroaniline	EPA 8270	Extractable Organics	NELAP	7/1/2003

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E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
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Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
2-Nitrophenol	EPA 625	Extractable Organics	NELAP	9/26/2001
2-Nitrophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
3,3'-Dichlorobenzidine	EPA 625	Extractable Organics	NELAP	9/26/2001
3,3'-Dichlorobenzidine	EPA 8270	Extractable Organics	NELAP	12/16/2003
3,3'-Dimethylbenzidine	EPA 8270	Extractable Organics	NELAP	11/20/2003
3-Methylcholanthrene	EPA 8270	Extractable Organics	NELAP	11/20/2003
3-Methylphenol (m-Cresol)	EPA 8270	Extractable Organics	NELAP	11/20/2003
3-Nitroaniline	EPA 8270	Extractable Organics	NELAP	7/1/2003
4,4'-DDD	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
4,4'-DDD	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
4,4'-DDE	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
4,4'-DDE	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
4,4'-DDT	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
4,4'-DDT	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
4-Aminobiphenyl	EPA 8270	Extractable Organics	NELAP	11/20/2003
4-Bromophenyl phenyl ether	EPA 625	Extractable Organics	NELAP	9/26/2001
4-Bromophenyl phenyl ether	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Chloro-3-methylphenol	EPA 625	Extractable Organics	NELAP	9/26/2001
4-Chloro-3-methylphenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
4-Chloroaniline	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Chlorophenyl phenylether	EPA 625	Extractable Organics	NELAP	9/26/2001
4-Chlorophenyl phenylether	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	11/30/2010
4-Dimethyl aminoazobenzene	EPA 8270	Extractable Organics	NELAP	10/26/2007
4-Methyl-2-pentanone (MIBK)	EPA 8260	Volatile Organics	NELAP	7/1/2003
4-Methylphenol (p-Cresol)	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Nitroaniline	EPA 8270	Extractable Organics	NELAP	7/1/2003
4-Nitrophenol	EPA 625	Extractable Organics	NELAP	9/26/2001
4-Nitrophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
5-Nitro-o-toluidine	EPA 8270	Extractable Organics	NELAP	10/26/2007
7,12-Dimethylbenz(a) anthracene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Acenaphthene	EPA 610	Extractable Organics	NELAP	11/30/2010
Acenaphthene	EPA 625	Extractable Organics	NELAP	9/26/2001
Acenaphthene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Acenaphthene	EPA 8310	Extractable Organics	NELAP	10/26/2007

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State Laboratory ID: E87674 **EPA Lab Code: NY00032** **(585) 288-5380**

E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Acenaphthylene	EPA 610	Extractable Organics	NELAP	11/30/2010
Acenaphthylene	EPA 625	Extractable Organics	NELAP	9/26/2001
Acenaphthylene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Acenaphthylene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Acetone	EPA 8260	Volatile Organics	NELAP	7/1/2003
Acetonitrile	EPA 8260	Volatile Organics	NELAP	11/20/2003
Acetophenone	EPA 8270	Extractable Organics	NELAP	11/20/2003
Acetylene	RSK-175	Volatile Organics	NELAP	11/30/2010
Acrolein (Propenal)	EPA 624	Volatile Organics	NELAP	9/10/2004
Acrolein (Propenal)	EPA 8260	Volatile Organics	NELAP	9/10/2004
Acrylonitrile	EPA 624	Volatile Organics	NELAP	9/10/2004
Acrylonitrile	EPA 8260	Volatile Organics	NELAP	9/10/2004
Aldrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Alkalinity as CaCO3	SM 2320 B	General Chemistry	NELAP	10/26/2007
Allyl chloride (3-Chloropropene)	EPA 8260	Volatile Organics	NELAP	11/20/2003
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
alpha-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Aluminum	EPA 200.7	Metals	NELAP	9/26/2001
Aluminum	EPA 6010	Metals	NELAP	12/16/2003
Ammonia as N	EPA 350.1	General Chemistry	NELAP	9/26/2001
Aniline	EPA 8270	Extractable Organics	NELAP	10/26/2007
Anthracene	EPA 610	Extractable Organics	NELAP	11/30/2010
Anthracene	EPA 625	Extractable Organics	NELAP	9/26/2001
Anthracene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Anthracene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Antimony	EPA 200.7	Metals	NELAP	9/26/2001
Antimony	EPA 200.8	Metals	NELAP	8/25/2003
Antimony	EPA 6010	Metals	NELAP	9/10/2004
Antimony	EPA 6020	Metals	NELAP	12/16/2003
Aroclor-1016 (PCB-1016)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1016 (PCB-1016)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Aroclor-1221 (PCB-1221)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1221 (PCB-1221)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/10/2004

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Aroclor-1232 (PCB-1232)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1232 (PCB-1232)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Aroclor-1242 (PCB-1242)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1242 (PCB-1242)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Aroclor-1248 (PCB-1248)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1248 (PCB-1248)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Aroclor-1254 (PCB-1254)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1254 (PCB-1254)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Aroclor-1260 (PCB-1260)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1260 (PCB-1260)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Aroclor-1262 (PCB-1262)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1268 (PCB-1268)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Arsenic	EPA 200.7	Metals	NELAP	9/26/2001
Arsenic	EPA 200.8	Metals	NELAP	8/25/2003
Arsenic	EPA 6010	Metals	NELAP	9/10/2004
Arsenic	EPA 6020	Metals	NELAP	12/16/2003
Arsenic	EPA 7010	Metals	NELAP	11/30/2010
Arsenic	EPA 7060	Metals	NELAP	10/26/2007
Arsenic	SM 3113 B	Metals	NELAP	10/26/2007
Atrazine	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Barium	EPA 200.7	Metals	NELAP	9/26/2001
Barium	EPA 200.8	Metals	NELAP	8/25/2003
Barium	EPA 6010	Metals	NELAP	9/10/2004
Barium	EPA 6020	Metals	NELAP	12/16/2003
Benzaldehyde	EPA 8270	Extractable Organics	NELAP	11/30/2010
Benzene	EPA 602	Volatile Organics	NELAP	9/26/2001
Benzene	EPA 624	Volatile Organics	NELAP	9/26/2001
Benzene	EPA 8021	Volatile Organics	NELAP	9/10/2004
Benzene	EPA 8260	Volatile Organics	NELAP	9/10/2004
Benzidine	EPA 625	Extractable Organics	NELAP	9/26/2001
Benzidine	EPA 8270	Extractable Organics	NELAP	11/7/2005
Benzo(a)anthracene	EPA 610	Extractable Organics	NELAP	11/30/2010
Benzo(a)anthracene	EPA 625	Extractable Organics	NELAP	9/26/2001
Benzo(a)anthracene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Benzo(a)anthracene	EPA 8310	Extractable Organics	NELAP	10/26/2007

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Benzo(a)pyrene	EPA 610	Extractable Organics	NELAP	11/30/2010
Benzo(a)pyrene	EPA 625	Extractable Organics	NELAP	9/26/2001
Benzo(a)pyrene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Benzo(a)pyrene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Benzo(b)fluoranthene	EPA 610	Extractable Organics	NELAP	11/30/2010
Benzo(b)fluoranthene	EPA 625	Extractable Organics	NELAP	9/26/2001
Benzo(b)fluoranthene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Benzo(b)fluoranthene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Benzo(g,h,i)perylene	EPA 610	Extractable Organics	NELAP	11/30/2010
Benzo(g,h,i)perylene	EPA 625	Extractable Organics	NELAP	9/26/2001
Benzo(g,h,i)perylene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Benzo(g,h,i)perylene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Benzo(k)fluoranthene	EPA 610	Extractable Organics	NELAP	11/30/2010
Benzo(k)fluoranthene	EPA 625	Extractable Organics	NELAP	9/26/2001
Benzo(k)fluoranthene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Benzo(k)fluoranthene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Benzoic acid	EPA 8270	Extractable Organics	NELAP	11/7/2005
Benzyl alcohol	EPA 8270	Extractable Organics	NELAP	11/20/2003
Benzyl chloride	EPA 8260	Volatile Organics	NELAP	11/30/2010
Beryllium	EPA 200.7	Metals	NELAP	9/26/2001
Beryllium	EPA 200.8	Metals	NELAP	8/25/2003
Beryllium	EPA 6010	Metals	NELAP	12/16/2003
Beryllium	EPA 6020	Metals	NELAP	12/16/2003
beta-BHC (beta-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
beta-BHC (beta-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Biochemical oxygen demand	SM 5210 B	General Chemistry	NELAP	10/26/2007
Biphenyl	EPA 8270	Extractable Organics	NELAP	11/30/2010
bis(2-Chloroethoxy)methane	EPA 625	Extractable Organics	NELAP	9/26/2001
bis(2-Chloroethoxy)methane	EPA 8270	Extractable Organics	NELAP	9/10/2004
bis(2-Chloroethyl) ether	EPA 625	Extractable Organics	NELAP	9/26/2001
bis(2-Chloroethyl) ether	EPA 8270	Extractable Organics	NELAP	11/20/2003
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 625	Extractable Organics	NELAP	9/26/2001
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270	Extractable Organics	NELAP	9/10/2004
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 625	Extractable Organics	NELAP	9/26/2001

Laboratory Scope of Accreditation

Attachment to Certificate #: E87674-19, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87674 **EPA Lab Code:** NY00032 **(585) 288-5380**

E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270	Extractable Organics	NELAP	9/10/2004
Boron	EPA 200.7	Metals	NELAP	9/26/2001
Boron	EPA 6010	Metals	NELAP	12/16/2003
Bromide	EPA 300.0	General Chemistry	NELAP	11/7/2005
Bromide	EPA 9056	General Chemistry	NELAP	10/26/2007
Bromochloromethane	EPA 8260	Volatile Organics	NELAP	10/26/2007
Bromodichloromethane	EPA 601	Volatile Organics	NELAP	9/26/2001
Bromodichloromethane	EPA 624	Volatile Organics	NELAP	9/26/2001
Bromodichloromethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
Bromodichloromethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
Bromoform	EPA 601	Volatile Organics	NELAP	9/26/2001
Bromoform	EPA 624	Volatile Organics	NELAP	9/26/2001
Bromoform	EPA 8021	Volatile Organics	NELAP	9/10/2004
Bromoform	EPA 8260	Volatile Organics	NELAP	9/10/2004
Butyl benzyl phthalate	EPA 625	Extractable Organics	NELAP	9/26/2001
Butyl benzyl phthalate	EPA 8270	Extractable Organics	NELAP	9/10/2004
Cadmium	EPA 200.7	Metals	NELAP	9/26/2001
Cadmium	EPA 200.8	Metals	NELAP	8/25/2003
Cadmium	EPA 6010	Metals	NELAP	9/10/2004
Cadmium	EPA 6020	Metals	NELAP	12/16/2003
Calcium	EPA 200.7	Metals	NELAP	9/26/2001
Calcium	EPA 6010	Metals	NELAP	12/16/2003
Caprolactam	EPA 8270	Extractable Organics	NELAP	11/30/2010
Carbazole	EPA 8270	Extractable Organics	NELAP	7/1/2003
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	7/1/2003
Carbon tetrachloride	EPA 601	Volatile Organics	NELAP	9/26/2001
Carbon tetrachloride	EPA 624	Volatile Organics	NELAP	9/26/2001
Carbon tetrachloride	EPA 8021	Volatile Organics	NELAP	11/7/2005
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	9/10/2004
Carbonaceous BOD (CBOD)	SM 5210 B	General Chemistry	NELAP	10/26/2007
Chemical oxygen demand	EPA 410.4	General Chemistry	NELAP	9/26/2001
Chlordane (tech.)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Chlordane (tech.)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Chloride	EPA 300.0	General Chemistry	NELAP	9/26/2001
Chloride	EPA 9056	General Chemistry	NELAP	10/26/2007

Laboratory Scope of Accreditation

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State Laboratory ID: E87674 **EPA Lab Code: NY00032** **(585) 288-5380**

E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Chloride	SM 4500-Cl^- E	General Chemistry	NELAP	10/26/2007
Chlorobenzene	EPA 601	Volatile Organics	NELAP	9/26/2001
Chlorobenzene	EPA 624	Volatile Organics	NELAP	9/26/2001
Chlorobenzene	EPA 8021	Volatile Organics	NELAP	11/7/2005
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	9/10/2004
Chlorobenzilate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Chloroethane	EPA 601	Volatile Organics	NELAP	9/26/2001
Chloroethane	EPA 624	Volatile Organics	NELAP	9/26/2001
Chloroethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
Chloroethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
Chloroform	EPA 601	Volatile Organics	NELAP	9/26/2001
Chloroform	EPA 624	Volatile Organics	NELAP	9/26/2001
Chloroform	EPA 8021	Volatile Organics	NELAP	9/10/2004
Chloroform	EPA 8260	Volatile Organics	NELAP	9/10/2004
Chloroprene	EPA 8260	Volatile Organics	NELAP	11/20/2003
Chromium	EPA 200.7	Metals	NELAP	9/26/2001
Chromium	EPA 200.8	Metals	NELAP	8/25/2003
Chromium	EPA 6010	Metals	NELAP	9/10/2004
Chromium	EPA 6020	Metals	NELAP	12/16/2003
Chromium VI	EPA 218.6	General Chemistry	NELAP	10/26/2007
Chromium VI	EPA 7196	General Chemistry	NELAP	12/16/2003
Chromium VI	EPA 7199	General Chemistry	NELAP	9/10/2004
Chromium VI	SM 3500-Cr B (20th/21st Ed.)/UV-VIS	General Chemistry	NELAP	10/26/2007
Chrysene	EPA 610	Extractable Organics	NELAP	11/30/2010
Chrysene	EPA 625	Extractable Organics	NELAP	9/26/2001
Chrysene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Chrysene	EPA 8310	Extractable Organics	NELAP	10/26/2007
cis-1,2-Dichloroethylene	EPA 8021	Volatile Organics	NELAP	7/1/2003
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	7/1/2003
cis-1,3-Dichloropropene	EPA 601	Volatile Organics	NELAP	9/26/2001
cis-1,3-Dichloropropene	EPA 624	Volatile Organics	NELAP	9/26/2001
cis-1,3-Dichloropropene	EPA 8021	Volatile Organics	NELAP	9/10/2004
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	9/10/2004
Cobalt	EPA 200.7	Metals	NELAP	9/26/2001
Cobalt	EPA 200.8	Metals	NELAP	8/25/2003

Laboratory Scope of Accreditation

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State Laboratory ID: E87674 **EPA Lab Code:** NY00032 **(585) 288-5380**

E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Cobalt	EPA 6010	Metals	NELAP	12/16/2003
Cobalt	EPA 6020	Metals	NELAP	12/16/2003
Color	SM 2120 B	General Chemistry	NELAP	10/26/2007
Conductivity	EPA 120.1	General Chemistry	NELAP	9/26/2001
Conductivity	EPA 9050	General Chemistry	NELAP	11/30/2010
Copper	EPA 200.7	Metals	NELAP	9/26/2001
Copper	EPA 200.8	Metals	NELAP	8/25/2003
Copper	EPA 6010	Metals	NELAP	12/16/2003
Copper	EPA 6020	Metals	NELAP	12/16/2003
Corrosivity (langlier index)	SM 2330 B	General Chemistry	NELAP	11/30/2010
Cyanide	EPA 335.4	General Chemistry	NELAP	9/26/2001
Cyanide	SM 4500-CN E	General Chemistry	NELAP	11/30/2010
Cyclohexane	EPA 8260	Volatile Organics	NELAP	11/30/2010
delta-BHC	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
delta-BHC	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Diallate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Dibenz(a,h)anthracene	EPA 610	Extractable Organics	NELAP	11/30/2010
Dibenz(a,h)anthracene	EPA 625	Extractable Organics	NELAP	9/26/2001
Dibenz(a,h)anthracene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Dibenz(a,h)anthracene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Dibenzofuran	EPA 8270	Extractable Organics	NELAP	7/1/2003
Dibromochloromethane	EPA 601	Volatile Organics	NELAP	9/26/2001
Dibromochloromethane	EPA 624	Volatile Organics	NELAP	9/26/2001
Dibromochloromethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
Dibromomethane	EPA 8260	Volatile Organics	NELAP	11/20/2003
Dicamba	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Dichlorodifluoromethane	EPA 601	Volatile Organics	NELAP	9/26/2001
Dichlorodifluoromethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
Dichlorodifluoromethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
Dieldrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Dieldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Diethyl phthalate	EPA 625	Extractable Organics	NELAP	9/26/2001
Diethyl phthalate	EPA 8270	Extractable Organics	NELAP	9/10/2004
Di-isopropylether (DIPE)	EPA 8015	Volatile Organics	NELAP	11/30/2010

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State Laboratory ID: E87674 **EPA Lab Code: NY00032** **(585) 288-5380**

E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
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Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Di-isopropylether (DIPE)	EPA 8260	Volatile Organics	NELAP	11/30/2010
Dimethoate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Dimethyl phthalate	EPA 625	Extractable Organics	NELAP	9/26/2001
Dimethyl phthalate	EPA 8270	Extractable Organics	NELAP	9/10/2004
Di-n-butyl phthalate	EPA 625	Extractable Organics	NELAP	9/26/2001
Di-n-butyl phthalate	EPA 8270	Extractable Organics	NELAP	9/10/2004
Di-n-octyl phthalate	EPA 625	Extractable Organics	NELAP	9/26/2001
Di-n-octyl phthalate	EPA 8270	Extractable Organics	NELAP	9/10/2004
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	11/20/2003
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Diphenylamine	EPA 8270	Extractable Organics	NELAP	10/26/2007
Disulfoton	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Endosulfan I	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Endosulfan I	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Endosulfan II	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Endosulfan II	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Endosulfan sulfate	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Endosulfan sulfate	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Endrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Endrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Endrin aldehyde	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Endrin aldehyde	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Endrin ketone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Ethane	RSK-175	Volatile Organics	NELAP	11/30/2010
Ethanol	EPA 8015	Volatile Organics	NELAP	10/26/2007
Ethyl acetate	EPA 8015	Volatile Organics	NELAP	11/30/2010
Ethyl acetate	EPA 8260	Volatile Organics	NELAP	11/30/2010
Ethyl methacrylate	EPA 8260	Volatile Organics	NELAP	10/26/2007
Ethyl methanesulfonate	EPA 8270	Extractable Organics	NELAP	11/20/2003
Ethylbenzene	EPA 602	Volatile Organics	NELAP	9/26/2001
Ethylbenzene	EPA 624	Volatile Organics	NELAP	9/26/2001
Ethylbenzene	EPA 8021	Volatile Organics	NELAP	9/10/2004
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	9/10/2004
Ethylene	RSK-175	Volatile Organics	NELAP	11/30/2010
Ethyl-t-butylether (ETBE)	EPA 8260	Volatile Organics	NELAP	11/30/2010

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E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
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Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Fluoranthene	EPA 610	Extractable Organics	NELAP	11/30/2010
Fluoranthene	EPA 625	Extractable Organics	NELAP	9/26/2001
Fluoranthene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Fluoranthene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Fluorene	EPA 610	Extractable Organics	NELAP	11/30/2010
Fluorene	EPA 625	Extractable Organics	NELAP	9/26/2001
Fluorene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Fluorene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Fluoride	EPA 300.0	General Chemistry	NELAP	9/26/2001
Fluoride	EPA 9056	General Chemistry	NELAP	10/26/2007
Formaldehyde	EPA 8315	Extractable Organics	NELAP	11/30/2010
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
gamma-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	7/1/2003
Hardness	SM 2340 B	General Chemistry	NELAP	10/26/2007
Hardness	SM 2340 C	General Chemistry	NELAP	10/26/2007
Hardness (calc.)	EPA 200.7	Metals	NELAP	10/26/2007
Heptachlor	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Heptachlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Heptachlor epoxide	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Heptachlor epoxide	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Hexachlorobenzene	EPA 625	Extractable Organics	NELAP	9/26/2001
Hexachlorobenzene	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Hexachlorobenzene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Hexachlorobutadiene	EPA 625	Extractable Organics	NELAP	9/26/2001
Hexachlorobutadiene	EPA 8260	Volatile Organics	NELAP	7/1/2003
Hexachlorobutadiene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Hexachlorocyclopentadiene	EPA 625	Extractable Organics	NELAP	9/26/2001
Hexachlorocyclopentadiene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Hexachloroethane	EPA 625	Extractable Organics	NELAP	9/26/2001
Hexachloroethane	EPA 8270	Extractable Organics	NELAP	9/10/2004
Hexachloropropene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Indeno(1,2,3-cd)pyrene	EPA 610	Extractable Organics	NELAP	11/30/2010
Indeno(1,2,3-cd)pyrene	EPA 625	Extractable Organics	NELAP	9/26/2001

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E87674
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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Indeno(1,2,3-cd)pyrene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Indeno(1,2,3-cd)pyrene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Iodomethane (Methyl iodide)	EPA 8260	Volatile Organics	NELAP	10/26/2007
Iron	EPA 200.7	Metals	NELAP	9/26/2001
Iron	EPA 6010	Metals	NELAP	12/16/2003
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8015	Volatile Organics	NELAP	11/30/2010
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260	Volatile Organics	NELAP	11/20/2003
Isodrin	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Isophorone	EPA 625	Extractable Organics	NELAP	9/26/2001
Isophorone	EPA 8270	Extractable Organics	NELAP	9/10/2004
Isopropylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
Isopropylbenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
Isosafrole	EPA 8270	Extractable Organics	NELAP	11/20/2003
Kepone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	11/20/2003
Kjeldahl nitrogen - total	EPA 351.2	General Chemistry	NELAP	10/26/2007
Lead	EPA 200.7	Metals	NELAP	9/26/2001
Lead	EPA 200.8	Metals	NELAP	8/25/2003
Lead	EPA 6010	Metals	NELAP	9/10/2004
Lead	EPA 6020	Metals	NELAP	12/16/2003
Lead	EPA 7010	Metals	NELAP	11/30/2010
Lead	SM 3113 B	Metals	NELAP	10/26/2007
Magnesium	EPA 200.7	Metals	NELAP	9/26/2001
Magnesium	EPA 6010	Metals	NELAP	12/16/2003
Manganese	EPA 200.7	Metals	NELAP	9/26/2001
Manganese	EPA 200.8	Metals	NELAP	8/25/2003
Manganese	EPA 6010	Metals	NELAP	12/16/2003
Manganese	EPA 6020	Metals	NELAP	12/16/2003
Mercury	EPA 1631	Metals	NELAP	10/26/2007
Mercury	EPA 245.1	Metals	NELAP	9/26/2001
Mercury	EPA 7470	Metals	NELAP	9/10/2004
Methacrylonitrile	EPA 8260	Volatile Organics	NELAP	10/26/2007
Methane	RSK-175	Volatile Organics	NELAP	11/30/2010
Methapyrilene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Methoxychlor	EPA 608.2	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Methoxychlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004

Laboratory Scope of Accreditation

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E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Methyl acetate	EPA 8260	Volatile Organics	NELAP	11/30/2010
Methyl bromide (Bromomethane)	EPA 601	Volatile Organics	NELAP	9/26/2001
Methyl bromide (Bromomethane)	EPA 624	Volatile Organics	NELAP	9/26/2001
Methyl bromide (Bromomethane)	EPA 8021	Volatile Organics	NELAP	9/10/2004
Methyl bromide (Bromomethane)	EPA 8260	Volatile Organics	NELAP	9/10/2004
Methyl chloride (Chloromethane)	EPA 601	Volatile Organics	NELAP	9/26/2001
Methyl chloride (Chloromethane)	EPA 624	Volatile Organics	NELAP	9/26/2001
Methyl chloride (Chloromethane)	EPA 8021	Volatile Organics	NELAP	9/10/2004
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	9/10/2004
Methyl methacrylate	EPA 8260	Volatile Organics	NELAP	10/26/2007
Methyl methanesulfonate	EPA 8270	Extractable Organics	NELAP	11/20/2003
Methyl parathion (Parathion, methyl)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Methyl tert-butyl ether (MTBE)	EPA 8021	Volatile Organics	NELAP	7/1/2003
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	7/1/2003
Methylcyclohexane	EPA 8260	Volatile Organics	NELAP	11/30/2010
Methylene chloride	EPA 601	Volatile Organics	NELAP	9/26/2001
Methylene chloride	EPA 624	Volatile Organics	NELAP	9/26/2001
Methylene chloride	EPA 8021	Volatile Organics	NELAP	9/10/2004
Methylene chloride	EPA 8260	Volatile Organics	NELAP	9/10/2004
Molybdenum	EPA 200.7	Metals	NELAP	9/26/2001
Molybdenum	EPA 200.8	Metals	NELAP	12/16/2003
Molybdenum	EPA 6010	Metals	NELAP	12/16/2003
Molybdenum	EPA 6020	Metals	NELAP	9/10/2004
Naphthalene	EPA 610	Extractable Organics	NELAP	11/30/2010
Naphthalene	EPA 625	Extractable Organics	NELAP	9/26/2001
Naphthalene	EPA 8260	Volatile Organics	NELAP	11/30/2010
Naphthalene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Naphthalene	EPA 8310	Extractable Organics	NELAP	10/26/2007
n-Butylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
n-Butylbenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
Nickel	EPA 200.7	Metals	NELAP	9/26/2001
Nickel	EPA 200.8	Metals	NELAP	8/25/2003
Nickel	EPA 6010	Metals	NELAP	9/10/2004
Nickel	EPA 6020	Metals	NELAP	12/16/2003
Nitrate	EPA 9056	General Chemistry	NELAP	10/26/2007

Laboratory Scope of Accreditation

Attachment to Certificate #: E87674-19, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87674 **EPA Lab Code: NY00032** **(585) 288-5380**

E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Nitrate as N	EPA 300.0	General Chemistry	NELAP	9/26/2001
Nitrate as N	EPA 353.2	General Chemistry	NELAP	9/26/2001
Nitrite	EPA 9056	General Chemistry	NELAP	10/26/2007
Nitrite as N	EPA 300.0	General Chemistry	NELAP	11/7/2005
Nitrite as N	EPA 353.2	General Chemistry	NELAP	9/26/2001
Nitrobenzene	EPA 625	Extractable Organics	NELAP	9/26/2001
Nitrobenzene	EPA 8270	Extractable Organics	NELAP	9/10/2004
n-Nitrosodiethylamine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosodimethylamine	EPA 625	Extractable Organics	NELAP	9/26/2001
n-Nitrosodimethylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitroso-di-n-butylamine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosodi-n-propylamine	EPA 625	Extractable Organics	NELAP	9/26/2001
n-Nitrosodi-n-propylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitrosodiphenylamine	EPA 625	Extractable Organics	NELAP	9/26/2001
n-Nitrosodiphenylamine	EPA 8270	Extractable Organics	NELAP	7/1/2003
n-Nitrosopiperidine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosopyrrolidine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Propylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
n-Propylbenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
o,o,o-Triethyl phosphorothioate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Oil & Grease	EPA 1664A	General Chemistry	NELAP	9/26/2001
Orthophosphate as P	EPA 365.1	General Chemistry	NELAP	9/10/2004
o-Toluidine	EPA 8260	Volatile Organics	NELAP	11/7/2005
Parathion, ethyl	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Pentachlorobenzene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Pentachlorophenol	EPA 625	Extractable Organics	NELAP	9/26/2001
Pentachlorophenol	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	11/20/2003
Pentachlorophenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
Perchlorate	EPA 6850	General Chemistry	NELAP	11/30/2010
Phenacetin	EPA 8270	Extractable Organics	NELAP	10/26/2007
Phenanthrene	EPA 610	Extractable Organics	NELAP	11/30/2010
Phenanthrene	EPA 625	Extractable Organics	NELAP	9/26/2001
Phenanthrene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Phenanthrene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Phenol	EPA 625	Extractable Organics	NELAP	9/26/2001

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Phenol	EPA 8270	Extractable Organics	NELAP	9/10/2004
Phorate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Phosphorus, total	EPA 365.1	General Chemistry	NELAP	9/10/2004
p-Isopropyltoluene	EPA 8021	Volatile Organics	NELAP	10/26/2007
p-Isopropyltoluene	EPA 8260	Volatile Organics	NELAP	10/26/2007
Potassium	EPA 200.7	Metals	NELAP	9/26/2001
Potassium	EPA 6010	Metals	NELAP	12/16/2003
Pronamide (Kerb)	EPA 8270	Extractable Organics	NELAP	11/20/2003
Propane	RSK-175	Volatile Organics	NELAP	11/30/2010
Propionitrile (Ethyl cyanide)	EPA 8260	Volatile Organics	NELAP	10/26/2007
Pyrene	EPA 610	Extractable Organics	NELAP	11/30/2010
Pyrene	EPA 625	Extractable Organics	NELAP	9/26/2001
Pyrene	EPA 8270	Extractable Organics	NELAP	9/10/2004
Pyrene	EPA 8310	Extractable Organics	NELAP	10/26/2007
Pyridine	EPA 625	Extractable Organics	NELAP	10/26/2007
Pyridine	EPA 8270	Extractable Organics	NELAP	7/1/2003
Residue-filterable (TDS)	SM 2540 C	General Chemistry	NELAP	9/26/2001
Residue-nonfilterable (TSS)	SM 2540 D	General Chemistry	NELAP	10/26/2007
Residue-settleable	SM 2540 F	General Chemistry	NELAP	10/26/2007
Residue-total	SM 2540 B	General Chemistry	NELAP	9/26/2001
Safrole	EPA 8270	Extractable Organics	NELAP	11/20/2003
sec-Butylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
sec-Butylbenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
Selenium	EPA 200.7	Metals	NELAP	9/26/2001
Selenium	EPA 200.8	Metals	NELAP	8/25/2003
Selenium	EPA 6010	Metals	NELAP	9/10/2004
Selenium	EPA 6020	Metals	NELAP	12/16/2003
Selenium	EPA 7010	Metals	NELAP	11/30/2010
Selenium	SM 3113 B	Metals	NELAP	10/26/2007
Silica-dissolved	USGS I-2700-85	General Chemistry	NELAP	10/26/2007
Silver	EPA 200.7	Metals	NELAP	9/26/2001
Silver	EPA 200.8	Metals	NELAP	8/25/2003
Silver	EPA 6010	Metals	NELAP	9/10/2004
Silver	EPA 6020	Metals	NELAP	12/16/2003
Silvex (2,4,5-TP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	9/10/2004

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Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Sodium	EPA 200.7	Metals	NELAP	9/26/2001
Sodium	EPA 6010	Metals	NELAP	12/16/2003
Strontium	EPA 200.7	Metals	NELAP	10/26/2007
Strontium	EPA 6010	Metals	NELAP	11/30/2010
Styrene	EPA 8260	Volatile Organics	NELAP	11/20/2003
Sulfate	EPA 300.0	General Chemistry	NELAP	9/26/2001
Sulfate	EPA 9056	General Chemistry	NELAP	10/26/2007
Sulfide	EPA 9030/9034	General Chemistry	NELAP	10/26/2007
Sulfide	SM 4500-S F	General Chemistry	NELAP	10/26/2007
Surfactants - MBAS	SM 5540 C	General Chemistry	NELAP	10/26/2007
T-amylmethylether (TAME)	EPA 8260	Volatile Organics	NELAP	11/30/2010
tert-Butyl alcohol	EPA 8260	Volatile Organics	NELAP	10/26/2007
tert-Butylbenzene	EPA 8260	Volatile Organics	NELAP	11/30/2010
Tetrachloroethylene (Perchloroethylene)	EPA 601	Volatile Organics	NELAP	9/26/2001
Tetrachloroethylene (Perchloroethylene)	EPA 624	Volatile Organics	NELAP	9/26/2001
Tetrachloroethylene (Perchloroethylene)	EPA 8021	Volatile Organics	NELAP	9/10/2004
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	9/10/2004
Thallium	EPA 200.7	Metals	NELAP	9/26/2001
Thallium	EPA 200.8	Metals	NELAP	8/25/2003
Thallium	EPA 279.2	Metals	NELAP	9/26/2001
Thallium	EPA 6010	Metals	NELAP	12/16/2003
Thallium	EPA 6020	Metals	NELAP	12/16/2003
Thallium	EPA 7010	Metals	NELAP	11/30/2010
Tin	EPA 200.7	Metals	NELAP	9/26/2001
Tin	EPA 6010	Metals	NELAP	12/16/2003
Titanium	EPA 200.7	Metals	NELAP	9/26/2001
Titanium	EPA 6010	Metals	NELAP	11/7/2005
Toluene	EPA 602	Volatile Organics	NELAP	9/26/2001
Toluene	EPA 624	Volatile Organics	NELAP	9/26/2001
Toluene	EPA 8021	Volatile Organics	NELAP	9/10/2004
Toluene	EPA 8260	Volatile Organics	NELAP	9/10/2004
Total cyanide	EPA 9012	General Chemistry	NELAP	9/10/2004
Total hardness as CaCO3	EPA 200.7	Metals	NELAP	9/26/2001
Total organic carbon	EPA 9060	General Chemistry	NELAP	10/26/2007
Total organic carbon	SM 5310 C	General Chemistry	NELAP	10/26/2007

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E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
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Rochester, NY 14623

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Total Petroleum Hydrocarbons (TPH)	EPA 1664A	General Chemistry	NELAP	10/26/2007
Total phenolics	EPA 420.4	General Chemistry	NELAP	10/26/2007
Total phenolics	EPA 9066	General Chemistry	NELAP	10/26/2007
Toxaphene (Chlorinated camphene)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Toxaphene (Chlorinated camphene)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
trans-1,2-Dichloroethylene	EPA 601	Volatile Organics	NELAP	9/26/2001
trans-1,2-Dichloroethylene	EPA 624	Volatile Organics	NELAP	9/26/2001
trans-1,2-Dichloroethylene	EPA 8021	Volatile Organics	NELAP	9/10/2004
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	11/20/2003
trans-1,3-Dichloropropene	EPA 601	Volatile Organics	NELAP	9/26/2001
trans-1,3-Dichloropropene	EPA 624	Volatile Organics	NELAP	9/26/2001
trans-1,3-Dichloropropene	EPA 8021	Volatile Organics	NELAP	9/10/2004
trans-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	9/10/2004
trans-1,4-Dichloro-2-butene	EPA 8260	Volatile Organics	NELAP	11/20/2003
Trichloroethene (Trichloroethylene)	EPA 601	Volatile Organics	NELAP	9/26/2001
Trichloroethene (Trichloroethylene)	EPA 624	Volatile Organics	NELAP	9/26/2001
Trichloroethene (Trichloroethylene)	EPA 8021	Volatile Organics	NELAP	9/10/2004
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	9/10/2004
Trichlorofluoromethane	EPA 601	Volatile Organics	NELAP	9/26/2001
Trichlorofluoromethane	EPA 624	Volatile Organics	NELAP	9/26/2001
Trichlorofluoromethane	EPA 8021	Volatile Organics	NELAP	9/10/2004
Trichlorofluoromethane	EPA 8260	Volatile Organics	NELAP	9/10/2004
Turbidity	EPA 180.1	General Chemistry	NELAP	10/26/2007
Uranium	EPA 6020	Metals	NELAP	11/30/2010
Vanadium	EPA 200.7	Metals	NELAP	9/26/2001
Vanadium	EPA 200.8	Metals	NELAP	8/25/2003
Vanadium	EPA 6010	Metals	NELAP	12/16/2003
Vanadium	EPA 6020	Metals	NELAP	12/16/2003
Vinyl acetate	EPA 8260	Volatile Organics	NELAP	11/20/2003
Vinyl chloride	EPA 601	Volatile Organics	NELAP	9/26/2001
Vinyl chloride	EPA 624	Volatile Organics	NELAP	9/26/2001
Vinyl chloride	EPA 8021	Volatile Organics	NELAP	9/10/2004
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	9/10/2004
Xylene (total)	EPA 602	Volatile Organics	NELAP	9/26/2001
Xylene (total)	EPA 624	Volatile Organics	NELAP	9/26/2001

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Xylene (total)	EPA 8021	Volatile Organics	NELAP	9/10/2004
Xylene (total)	EPA 8260	Volatile Organics	NELAP	9/10/2004
Zinc	EPA 200.7	Metals	NELAP	9/26/2001
Zinc	EPA 200.8	Metals	NELAP	8/25/2003
Zinc	EPA 6010	Metals	NELAP	12/16/2003
Zinc	EPA 6020	Metals	NELAP	12/16/2003

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Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	EPA 8260	Volatile Organics	NELAP	11/30/2010
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,1-Dichloropropene	EPA 8260	Volatile Organics	NELAP	11/7/2005
1,2,3-Trichloropropane	EPA 8260	Volatile Organics	NELAP	11/20/2003
1,2,4,5-Tetrachlorobenzene	EPA 8270	Extractable Organics	NELAP	11/20/2003
1,2,4-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	11/7/2005
1,2,4-Trichlorobenzene	EPA 8270	Extractable Organics	NELAP	9/26/2001
1,2,4-Trimethylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
1,2,4-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	11/7/2005
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,2-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	9/26/2001
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,2-Diphenylhydrazine	EPA 8270	Extractable Organics	NELAP	11/7/2005
1,3,5-Trimethylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
1,3,5-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	11/7/2005
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8270	Extractable Organics	NELAP	11/30/2010
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8330	Extractable Organics	NELAP	10/26/2007
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,3-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	9/26/2001
1,3-Dichloropropane	EPA 8260	Volatile Organics	NELAP	11/7/2005
1,3-Dinitrobenzene (1,3-DNB)	EPA 8270	Extractable Organics	NELAP	11/30/2010
1,3-Dinitrobenzene (1,3-DNB)	EPA 8330	Extractable Organics	NELAP	10/26/2007
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	9/26/2001
1,4-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	9/26/2001
1,4-Dioxane (1,4-Diethyleneoxide)	EPA 8260	Volatile Organics	NELAP	10/26/2007
1,4-Naphthoquinone	EPA 8270	Extractable Organics	NELAP	11/20/2003
1,4-Phenylenediamine	EPA 8270	Extractable Organics	NELAP	11/20/2003

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E87674
Columbia Analytical Services, Inc. - NY
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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
1-Chloronaphthalene	EPA 8270	Extractable Organics	NELAP	11/7/2005
1-Naphthylamine	EPA 8270	Extractable Organics	NELAP	11/20/2003
2,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	11/7/2005
2,3,4,6-Tetrachlorophenol	EPA 8270	Extractable Organics	NELAP	11/20/2003
2,4,5-T	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
2,4,5-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	6/23/2003
2,4,6-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
2,4,6-Trinitrotoluene (2,4,6-TNT)	EPA 8330	Extractable Organics	NELAP	10/26/2007
2,4-D	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
2,4-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
2,4-Dimethylphenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
2,4-Dinitrophenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270	Extractable Organics	NELAP	9/26/2001
2,4-Dinitrotoluene (2,4-DNT)	EPA 8330	Extractable Organics	NELAP	10/26/2007
2,6-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	11/20/2003
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270	Extractable Organics	NELAP	9/26/2001
2,6-Dinitrotoluene (2,6-DNT)	EPA 8330	Extractable Organics	NELAP	10/26/2007
2-Amino-4,6-dinitrotoluene (2-am-dnt)	EPA 8330	Extractable Organics	NELAP	10/26/2007
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260	General Chemistry	NELAP	11/20/2003
2-Chloroethyl vinyl ether	EPA 8260	Volatile Organics	NELAP	11/20/2003
2-Chloronaphthalene	EPA 8270	Extractable Organics	NELAP	9/26/2001
2-Chlorophenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
2-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	11/7/2005
2-Hexanone	EPA 8260	Volatile Organics	NELAP	11/20/2003
2-Methyl-4,6-dinitrophenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
2-Methylnaphthalene	EPA 8270	Extractable Organics	NELAP	9/26/2001
2-Methylphenol (o-Cresol)	EPA 8270	Extractable Organics	NELAP	6/23/2003
2-Naphthylamine	EPA 8270	Extractable Organics	NELAP	11/20/2003
2-Nitroaniline	EPA 8270	Extractable Organics	NELAP	9/26/2001
2-Nitrophenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
2-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	10/26/2007
3,3'-Dichlorobenzidine	EPA 8270	Extractable Organics	NELAP	9/26/2001
3,3'-Dimethylbenzidine	EPA 8270	Extractable Organics	NELAP	11/20/2003
3-Methylcholanthrene	EPA 8270	Extractable Organics	NELAP	11/20/2003
3-Methylphenol (m-Cresol)	EPA 8270	Extractable Organics	NELAP	11/20/2003

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
3-Nitroaniline	EPA 8270	Extractable Organics	NELAP	9/26/2001
3-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	10/26/2007
4,4'-DDD	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
4,4'-DDE	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
4,4'-DDT	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
4-Amino-2,6-dinitrotoluene (4-am-dnt)	EPA 8330	Extractable Organics	NELAP	10/26/2007
4-Aminobiphenyl	EPA 8270	Extractable Organics	NELAP	11/20/2003
4-Bromophenyl phenyl ether	EPA 8270	Extractable Organics	NELAP	6/23/2003
4-Chloro-3-methylphenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
4-Chloroaniline	EPA 8270	Extractable Organics	NELAP	9/26/2001
4-Chlorophenyl phenylether	EPA 8270	Extractable Organics	NELAP	6/23/2003
4-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	11/7/2005
4-Dimethyl aminoazobenzene	EPA 8270	Extractable Organics	NELAP	11/20/2003
4-Methyl-2-pentanone (MIBK)	EPA 8260	Volatile Organics	NELAP	9/26/2001
4-Methylphenol (p-Cresol)	EPA 8270	Extractable Organics	NELAP	9/26/2001
4-Nitroaniline	EPA 8270	Extractable Organics	NELAP	9/26/2001
4-Nitrophenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
4-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	10/26/2007
5-Chloro-2-methylaniline	EPA 8270	Extractable Organics	NELAP	10/26/2007
5-Nitro-o-toluidine	EPA 8270	Extractable Organics	NELAP	11/20/2003
7,12-Dimethylbenz(a) anthracene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Acenaphthene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Acenaphthylene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Acetone	EPA 8260	Volatile Organics	NELAP	9/26/2001
Acetonitrile	EPA 8260	Volatile Organics	NELAP	11/20/2003
Acetophenone	EPA 8270	Extractable Organics	NELAP	11/20/2003
Acrolein (Propenal)	EPA 8260	Volatile Organics	NELAP	9/26/2001
Acrylonitrile	EPA 8260	Volatile Organics	NELAP	9/26/2001
Aldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Allyl chloride (3-Chloropropene)	EPA 8260	Volatile Organics	NELAP	11/20/2003
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
alpha-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Aluminum	EPA 6010	Metals	NELAP	9/26/2001
Aniline	EPA 8270	Extractable Organics	NELAP	11/20/2003
Anthracene	EPA 8270	Extractable Organics	NELAP	9/26/2001

Laboratory Scope of Accreditation

Attachment to Certificate #: E87674-19, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87674 **EPA Lab Code:** NY00032 **(585) 288-5380**

E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Antimony	EPA 6010	Metals	NELAP	9/26/2001
Antimony	EPA 6020	Metals	NELAP	8/25/2003
Aramite	EPA 8270	Extractable Organics	NELAP	11/20/2003
Aroclor-1016 (PCB-1016)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Aroclor-1221 (PCB-1221)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Aroclor-1232 (PCB-1232)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Aroclor-1242 (PCB-1242)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Aroclor-1248 (PCB-1248)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Aroclor-1254 (PCB-1254)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Aroclor-1260 (PCB-1260)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Aroclor-1262 (PCB-1262)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Aroclor-1268 (PCB-1268)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Arsenic	EPA 6010	Metals	NELAP	9/26/2001
Arsenic	EPA 6020	Metals	NELAP	8/25/2003
Arsenic	EPA 7060	Metals	NELAP	9/26/2001
Atrazine	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Barium	EPA 6010	Metals	NELAP	9/26/2001
Barium	EPA 6020	Metals	NELAP	8/25/2003
Benzaldehyde	EPA 8270	Extractable Organics	NELAP	11/30/2010
Benzene	EPA 8021	Volatile Organics	NELAP	9/26/2001
Benzene	EPA 8260	Volatile Organics	NELAP	9/26/2001
Benzidine	EPA 8270	Extractable Organics	NELAP	11/7/2005
Benzo(a)anthracene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Benzo(a)pyrene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Benzo(b)fluoranthene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Benzo(g,h,i)perylene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Benzo(k)fluoranthene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Benzoic acid	EPA 8270	Extractable Organics	NELAP	11/20/2003
Benzyl alcohol	EPA 8270	Extractable Organics	NELAP	11/20/2003
Beryllium	EPA 6010	Metals	NELAP	9/26/2001
Beryllium	EPA 6020	Metals	NELAP	11/20/2003
beta-BHC (beta-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Biphenyl	EPA 8270	Extractable Organics	NELAP	11/30/2010
bis(2-Chloroethoxy)methane	EPA 8270	Extractable Organics	NELAP	9/26/2001
bis(2-Chloroethyl) ether	EPA 8270	Extractable Organics	NELAP	11/20/2003

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Analyte	Method/Tech	Category	Certification Type	Effective Date
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270	Extractable Organics	NELAP	9/26/2001
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270	Extractable Organics	NELAP	9/26/2001
Boron	EPA 6010	Metals	NELAP	9/26/2001
Bromide	EPA 9056	General Chemistry	NELAP	10/26/2007
Bromobenzene	EPA 8260	Volatile Organics	NELAP	11/7/2005
Bromochloromethane	EPA 8260	Volatile Organics	NELAP	11/7/2005
Bromodichloromethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
Bromoform	EPA 8260	Volatile Organics	NELAP	9/26/2001
Butyl benzyl phthalate	EPA 8270	Extractable Organics	NELAP	9/26/2001
Cadmium	EPA 6010	Metals	NELAP	9/26/2001
Cadmium	EPA 6020	Metals	NELAP	8/25/2003
Calcium	EPA 6010	Metals	NELAP	9/26/2001
Caprolactam	EPA 8270	Extractable Organics	NELAP	11/30/2010
Carbazole	EPA 8270	Extractable Organics	NELAP	9/26/2001
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	9/26/2001
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	9/26/2001
Chlordane (tech.)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Chloride	EPA 9056	General Chemistry	NELAP	10/26/2007
Chlorobenzene	EPA 8021	Volatile Organics	NELAP	9/26/2001
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	9/26/2001
Chlorobenzilate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Chloroethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
Chloroform	EPA 8260	Volatile Organics	NELAP	9/26/2001
Chloroprene	EPA 8260	Volatile Organics	NELAP	11/20/2003
Chromium	EPA 6010	Metals	NELAP	9/26/2001
Chromium	EPA 6020	Metals	NELAP	8/25/2003
Chromium VI	EPA 7196	General Chemistry	NELAP	9/26/2001
Chromium VI	EPA 7199	General Chemistry	NELAP	8/25/2003
Chrysene	EPA 8270	Extractable Organics	NELAP	9/26/2001
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	9/26/2001
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	9/26/2001
Cobalt	EPA 6010	Metals	NELAP	9/26/2001
Cobalt	EPA 6020	Metals	NELAP	11/20/2003
Copper	EPA 6010	Metals	NELAP	9/26/2001
Copper	EPA 6020	Metals	NELAP	11/20/2003

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E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Suite 360
Rochester, NY 14623

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Cyclohexane	EPA 8260	Volatile Organics	NELAP	11/30/2010
delta-BHC	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Diallate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Dibenz(a,h)anthracene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Dibenzofuran	EPA 8270	Extractable Organics	NELAP	6/23/2003
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
Dibromomethane	EPA 8260	Volatile Organics	NELAP	11/20/2003
Dicamba	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Dichlorodifluoromethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
Dieldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Diesel range organics (DRO)	EPA 8015	Extractable Organics	NELAP	11/30/2010
Diethyl phthalate	EPA 8270	Extractable Organics	NELAP	9/26/2001
Dimethoate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Dimethyl phthalate	EPA 8270	Extractable Organics	NELAP	9/26/2001
Di-n-butyl phthalate	EPA 8270	Extractable Organics	NELAP	9/26/2001
Di-n-octyl phthalate	EPA 8270	Extractable Organics	NELAP	9/26/2001
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	11/30/2010
Diphenylamine	EPA 8270	Extractable Organics	NELAP	11/20/2003
Disulfoton	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Endosulfan I	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Endosulfan II	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Endosulfan sulfate	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Endrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Endrin aldehyde	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Endrin ketone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Ethyl acetate	EPA 8260	Volatile Organics	NELAP	11/7/2005
Ethyl methacrylate	EPA 8260	Volatile Organics	NELAP	11/20/2003
Ethyl methanesulfonate	EPA 8270	Extractable Organics	NELAP	11/20/2003
Ethylbenzene	EPA 8021	Volatile Organics	NELAP	9/26/2001
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	9/26/2001
Fluoranthene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Fluorene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Fluoride	EPA 9056	General Chemistry	NELAP	10/26/2007
Formaldehyde	EPA 8315	Extractable Organics	NELAP	11/30/2010
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001

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E87674
Columbia Analytical Services, Inc. - NY
1565 Jefferson Road
Building 300, Snite 360
Rochester, NY 14623

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
gamma-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Gasoline range organics (GRO)	EPA 8015	Extractable Organics	NELAP	11/30/2010
Heptachlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Heptachlor epoxide	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Hexachlorobenzene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Hexachlorobutadiene	EPA 8260	Volatile Organics	NELAP	9/26/2001
Hexachlorobutadiene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Hexachlorocyclopentadiene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Hexachloroethane	EPA 8270	Extractable Organics	NELAP	9/26/2001
Hexachlorophene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Hexachloropropene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Ignitability	EPA 1010	General Chemistry	NELAP	9/26/2001
Indeno(1,2,3-cd)pyrene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Iron	EPA 6010	Metals	NELAP	9/26/2001
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260	Volatile Organics	NELAP	11/20/2003
Isophorone	EPA 8270	Extractable Organics	NELAP	9/26/2001
Isopropylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
Isopropylbenzene	EPA 8260	Volatile Organics	NELAP	11/7/2005
Isosafrole	EPA 8270	Extractable Organics	NELAP	10/26/2007
Kepone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	11/20/2003
Lead	EPA 6010	Metals	NELAP	9/26/2001
Lead	EPA 6020	Metals	NELAP	8/25/2003
Lithium	EPA 6010	Metals	NELAP	10/26/2007
Magnesium	EPA 6010	Metals	NELAP	9/26/2001
Manganese	EPA 6010	Metals	NELAP	9/26/2001
Manganese	EPA 6020	Metals	NELAP	11/20/2003
Mercury	EPA 7471	Metals	NELAP	9/26/2001
Methacrylonitrile	EPA 8260	Volatile Organics	NELAP	11/20/2003
Methapyrilene	EPA 8270	Extractable Organics	NELAP	11/20/2003
Methoxychlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Methyl acetate	EPA 8260	Volatile Organics	NELAP	11/30/2010
Methyl bromide (Bromomethane)	EPA 8260	Volatile Organics	NELAP	9/26/2001
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	9/26/2001
Methyl methacrylate	EPA 8260	Volatile Organics	NELAP	11/20/2003
Methyl methanesulfonate	EPA 8270	Extractable Organics	NELAP	11/20/2003

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Columbia Analytical Services, Inc. - NY
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Rochester, NY 14623

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Methyl parathion (Parathion, methyl)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Methyl tert-butyl ether (MTBE)	EPA 8021	Volatile Organics	NELAP	10/26/2007
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	10/26/2007
Methylcyclohexane	EPA 8260	Volatile Organics	NELAP	11/30/2010
Methylene chloride	EPA 8260	Volatile Organics	NELAP	9/26/2001
Molybdenum	EPA 6010	Metals	NELAP	10/26/2007
Molybdenum	EPA 6020	Metals	NELAP	11/7/2005
Naphthalene	EPA 8260	Volatile Organics	NELAP	10/26/2007
Naphthalene	EPA 8270	Extractable Organics	NELAP	9/26/2001
n-Butylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
n-Butylbenzene	EPA 8260	Volatile Organics	NELAP	11/7/2005
Nickel	EPA 6010	Metals	NELAP	9/26/2001
Nickel	EPA 6020	Metals	NELAP	8/25/2003
Nitrate	EPA 9056	General Chemistry	NELAP	10/26/2007
Nitrite	EPA 9056	General Chemistry	NELAP	10/26/2007
Nitrobenzene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Nitrobenzene	EPA 8330	Extractable Organics	NELAP	10/26/2007
Nitroquinoline-1-oxide	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosodiethylamine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosodimethylamine	EPA 8270	Extractable Organics	NELAP	9/26/2001
n-Nitroso-di-n-butylamine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosodi-n-propylamine	EPA 8270	Extractable Organics	NELAP	6/23/2003
n-Nitrosodiphenylamine	EPA 8270	Extractable Organics	NELAP	9/26/2001
n-Nitrosomethylethylamine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosomorpholine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosopiperidine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Nitrosopyrrolidine	EPA 8270	Extractable Organics	NELAP	11/20/2003
n-Propylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
n-Propylbenzene	EPA 8260	Volatile Organics	NELAP	10/26/2007
o,o,o-Triethyl phosphorothioate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	11/20/2003
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	EPA 8330	Extractable Organics	NELAP	10/26/2007
o-Toluidine	EPA 8260	Volatile Organics	NELAP	11/7/2005
Parathion, ethyl	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
p-Dioxane	EPA 8260	Volatile Organics	NELAP	9/26/2001
Pentachlorobenzene	EPA 8270	Extractable Organics	NELAP	10/26/2007

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Pentachloronitrobenzene (Quintozene)	EPA 8270	Extractable Organics	NELAP	10/26/2007
Pentachlorophenol	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Pentachlorophenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
Perchlorate	EPA 6850	General Chemistry	NELAP	11/30/2010
Phenacetin	EPA 8270	Extractable Organics	NELAP	11/20/2003
Phenanthrene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Phenol	EPA 8270	Extractable Organics	NELAP	9/26/2001
Phorate	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
p-Isopropyltoluene	EPA 8021	Volatile Organics	NELAP	10/26/2007
p-Isopropyltoluene	EPA 8260	Volatile Organics	NELAP	10/26/2007
Potassium	EPA 6010	Metals	NELAP	9/26/2001
Pronamide (Kerb)	EPA 8270	Extractable Organics	NELAP	11/20/2003
Propionitrile (Ethyl cyanide)	EPA 8260	Volatile Organics	NELAP	11/20/2003
Pyrene	EPA 8270	Extractable Organics	NELAP	9/26/2001
Pyridine	EPA 8270	Extractable Organics	NELAP	9/26/2001
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	EPA 8330	Extractable Organics	NELAP	10/26/2007
Reactive cyanide	Sec. 7.3 SW-846	General Chemistry	NELAP	9/26/2001
Reactive sulfide	Sec. 7.3 SW-846	General Chemistry	NELAP	9/26/2001
Safrole	EPA 8270	Extractable Organics	NELAP	11/20/2003
sec-Butylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007
sec-Butylbenzene	EPA 8260	Volatile Organics	NELAP	11/7/2005
Selenium	EPA 6010	Metals	NELAP	9/26/2001
Selenium	EPA 6020	Metals	NELAP	12/16/2003
Silver	EPA 6010	Metals	NELAP	9/26/2001
Silver	EPA 6020	Metals	NELAP	8/25/2003
Silvex (2,4,5-TP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	9/26/2001
Sodium	EPA 6010	Metals	NELAP	9/26/2001
Strontium	EPA 6010	Metals	NELAP	10/26/2007
Styrene	EPA 8260	Volatile Organics	NELAP	11/20/2003
Sulfate	EPA 9056	General Chemistry	NELAP	10/26/2007
Sulfide	EPA 9030/9034	General Chemistry	NELAP	9/26/2001
Sulfotepp	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Synthetic Precipitation Leaching Procedure	EPA 1312	General Chemistry	NELAP	11/30/2010
tert-Butyl alcohol	EPA 8260	Volatile Organics	NELAP	10/26/2007
tert-Butylbenzene	EPA 8021	Volatile Organics	NELAP	10/26/2007

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
tert-Butylbenzene	EPA 8260	Volatile Organics	NELAP	11/7/2005
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	9/26/2001
Tetryl (methyl-2,4,6-trinitrophenylnitramine)	EPA 8330	Extractable Organics	NELAP	10/26/2007
Thallium	EPA 6010	Metals	NELAP	9/26/2001
Thallium	EPA 6020	Metals	NELAP	11/20/2003
Thionazin (Zinophos)	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	10/26/2007
Tin	EPA 6010	Metals	NELAP	9/26/2001
Toluene	EPA 8021	Volatile Organics	NELAP	9/26/2001
Toluene	EPA 8260	Volatile Organics	NELAP	9/26/2001
Total cyanide	EPA 9012	General Chemistry	NELAP	9/26/2001
Total phenolics	EPA 9066	General Chemistry	NELAP	10/26/2007
Toxaphene (Chlorinated camphene)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	9/10/2004
Toxicity Characteristic Leaching Procedure	EPA 1311	General Chemistry	NELAP	9/26/2001
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	11/20/2003
trans-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	9/26/2001
trans-1,4-Dichloro-2-butene	EPA 8260	Volatile Organics	NELAP	11/20/2003
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	9/26/2001
Trichlorofluoromethane	EPA 8260	Volatile Organics	NELAP	9/26/2001
Vanadium	EPA 6010	Metals	NELAP	9/26/2001
Vanadium	EPA 6020	Metals	NELAP	11/20/2003
Vinyl acetate	EPA 8260	Volatile Organics	NELAP	11/20/2003
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	9/26/2001
Xylene (total)	EPA 8021	Volatile Organics	NELAP	9/26/2001
Xylene (total)	EPA 8260	Volatile Organics	NELAP	9/26/2001
Zinc	EPA 6010	Metals	NELAP	9/26/2001
Zinc	EPA 6020	Metals	NELAP	11/20/2003

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

Columbia Analytical Services

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14623

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 4.1 4/22/2009 and is accredited is accordance with the:

United States Department of Defense
Environmental Laboratory Accreditation Program
(DoD-ELAP)

This accreditation demonstrates technical competence for the defined scope:

Environmental Testing

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Initial Accreditation Date:	*Issue Date:*	*Accreditation No.:*	*Certificate No.:*
January 22, 2010	April 7, 2012	65817	L12-48

Tracy Szerszen
President/Operations Manager

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Columbia Analytical Services

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609
Lisa Reyes Phone: 585-288-5380

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	(CAS SOP) GEN-TICW	UV-VIS	Total inorganic carbon
Aqueous	EPA 1631	CVAFS	Mercury
Aqueous	EPA 1664A	Gravimetric	Oil and grease
Aqueous	EPA 1664A	Gravimetric	Total petroleum hydrocarbons
Aqueous	EPA 218.6	IC-UV	Chromium, Hexavalent
Aqueous	EPA 245.1	CVAA	Mercury
Aqueous	EPA 300.0	IC	Chloride
Aqueous	EPA 300.0	IC	Fluoride
Aqueous	EPA 300.0	IC	Nitrate
Aqueous	EPA 300.0	IC	Sulfate
Aqueous	EPA 351.2	UV-VIS	Nitrogen, total Kjeldahl
Aqueous	EPA 353.2	UV-VIS	Nitrite as N
Aqueous	EPA 410.4	UV-VIS	Chemical oxygen demand
Aqueous	EPA 7470A	CVAA	Mercury
Aqueous	EPA 8151A	GC-ECD	Dinoseb
Aqueous	EPA 8260C	GC-MS-SIM	1,1-Dichloroethene
Aqueous	EPA 8260C	GC-MS-SIM	1,2-Dichlorobenzene
Aqueous	EPA 8260C	GC-MS-SIM	1,2-Dichloroethane
Aqueous	EPA 8260C	GC-MS-SIM	1,4-Dioxane
Aqueous	EPA 8260C	GC-MS-SIM	Carbon tetrachloride
Aqueous	EPA 8260C	GC-MS-SIM	Dichloromethane
Aqueous	EPA 8260C	GC-MS-SIM	Ethylbenzene
Aqueous	EPA 8260C	GC-MS-SIM	m- + p-Xylene
Aqueous	EPA 8260C	GC-MS-SIM	o-Xylene
Aqueous	EPA 8260C	GC-MS-SIM	Tetrachloroethene
Aqueous	EPA 8260C	GC-MS-SIM	Trichloroethene
Aqueous	EPA 8260C	GC-MS-SIM	Vinyl chloride
Aqueous	EPA 8260C	GC-MS-SIM	Xylenes, total
Aqueous	EPA 8310	HPLC-UV/FLUOR	Acenaphthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Acenaphthylene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Anthracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(a)antracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(a)pyrene

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Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(b)fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(g,h,i)perylene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(k)fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Chrysene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Dibenzo(a,h)anthracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Fluorene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Indeno(1,2,3-cd)pyrene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Naphthalene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Phenanthrene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Pyrene
Aqueous	EPA 9040B, C	POT	pH
Aqueous	EPA 9060, A	UV-VIS	Total organic carbon
Aqueous	EPA 9066	UV-VIS	Phenolics, total
Aqueous	RSK-175	GC-FID	Ethane
Aqueous	RSK-175	GC-FID	Ethylene
Aqueous	RSK-175	GC-FID	Methane
Aqueous	RSK-175	GC-FID	Propane
Aqueous	RSK-175	GC-FID	Acetylene
Aqueous	SM 2320B	Titration	Alkalinity, total, carbonate, and bicarbonate
Aqueous	SM 2340C	Titration	Hardness, total
Solids	(CAS SOP) GEN-351.2	UV-VIS	Nitrogen, total Kjeldahl
Solids	(CAS SOP) GEN-420.4/9066	UV-VIS	Phenolics, total
Solids	EPA Lloyd Kahn	UV-VIS	Total organic carbon
Solids	EPA 300.0	IC	Chloride
Solids	EPA 300.0	IC	Fluoride
Solids	EPA 300.0	IC	Nitrate
Solids	EPA 300.0	IC	Sulfate
Solids	EPA 7471B	CVAA	Mercury
Solids	EPA 8330A	HPLC-UV	1,3,5-Trinitrobenzene
Solids	EPA 8330A	HPLC-UV	1,3-Dinitrobenzene
Solids	EPA 8330A	HPLC-UV	2,4,6-Trinitrotoluene
Solids	EPA 8330A	HPLC-UV	2,4-Dinitrotoluene

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Matrix	Standard/Method	Technology	Analyte
Solids	EPA 8330A	HPLC-UV	2,6-Dinitrotoluene
Solids	EPA 8330A	HPLC-UV	2-Amino-4,6-dinitrotoluene
Solids	EPA 8330A	HPLC-UV	2-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	3-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	4-Amino-2,6-dinitrotoluene
Solids	EPA 8330A	HPLC-UV	4-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	HMX
Solids	EPA 8330A	HPLC-UV	Nitrobenzene
Solids	EPA 8330A	HPLC-UV	RDX
Solids	EPA 8330A	HPLC-UV	Tetryl
Solids	EPA 9045C, D	POT	pH
Solids	SM 5220B	Titration	Chemical oxygen demand
Aqueous/Solids	EPA 1010A	Pensky Martin	Ignitability
Aqueous/Solids	EPA 353.2	UV-VIS	Nitrate/nitrite as N
Aqueous/Solids	EPA 6010C	ICP-AES	Aluminum
Aqueous/Solids	EPA 6010C	ICP-AES	Antimony
Aqueous/Solids	EPA 6010C	ICP-AES	Arsenic
Aqueous/Solids	EPA 6010C	ICP-AES	Barium
Aqueous/Solids	EPA 6010C	ICP-AES	Beryllium
Aqueous/Solids	EPA 6010C	ICP-AES	Boron
Aqueous/Solids	EPA 6010C	ICP-AES	Cadmium
Aqueous/Solids	EPA 6010C	ICP-AES	Calcium
Aqueous/Solids	EPA 6010C	ICP-AES	Chromium
Aqueous/Solids	EPA 6010C	ICP-AES	Cobalt
Aqueous/Solids	EPA 6010C	ICP-AES	Copper
Aqueous/Solids	EPA 6010C	ICP-AES	Iron
Aqueous/Solids	EPA 6010C	ICP-AES	Lead
Aqueous/Solids	EPA 6010C	ICP-AES	Magnesium
Aqueous/Solids	EPA 6010C	ICP-AES	Manganese
Aqueous/Solids	EPA 6010C	ICP-AES	Nickel
Aqueous/Solids	EPA 6010C	ICP-AES	Potassium
Aqueous/Solids	EPA 6010C	ICP-AES	Selenium
Aqueous/Solids	EPA 6010C	ICP-AES	Silver

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Aqueous/Solids	EPA 6010C	ICP-AES	Sodium
Aqueous/Solids	EPA 6010C	ICP-AES	Thallium
Aqueous/Solids	EPA 6010C	ICP-AES	Tin
Aqueous/Solids	EPA 6010C	ICP-AES	Vanadium
Aqueous/Solids	EPA 6010C	ICP-AES	Zinc
Aqueous/Solids	EPA 6020A	ICP-MS	Arsenic
Aqueous/Solids	EPA 6020A	ICP-MS	Antimony
Aqueous/Solids	EPA 6020A	ICP-MS	Barium
Aqueous/Solids	EPA 6020A	ICP-MS	Beryllium
Aqueous/Solids	EPA 6020A	ICP-MS	Cadmium
Aqueous/Solids	EPA 6020A	ICP-MS	Chromium
Aqueous/Solids	EPA 6020A	ICP-MS	Cobalt
Aqueous/Solids	EPA 6020A	ICP-MS	Copper
Aqueous/Solids	EPA 6020A	ICP-MS	Lead
Aqueous/Solids	EPA 6020A	ICP-MS	Manganese
Aqueous/Solids	EPA 6020A	ICP-MS	Nickel
Aqueous/Solids	EPA 6020A	ICP-MS	Selenium
Aqueous/Solids	EPA 6020A	ICP-MS	Silver
Aqueous/Solids	EPA 6020A	ICP-MS	Thallium
Aqueous/Solids	EPA 6020A	ICP-MS	Vanadium
Aqueous/Solids	EPA 6020A	ICP-MS	Zinc
Aqueous/Solids	EPA 680	GC-MS	Monochlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Dichlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Trichlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Tetrachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Pentachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Hexachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Heptachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Octachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Nonachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Decachlorobiphenyls, Total
Aqueous/Solids	EPA 6850	HPLC-MS	Perchlorate

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Aqueous/Solids	EPA 7196A	UV-VIS	Chromium, hexavalent
Aqueous/Solids	EPA 7199	IC-UV	Chromium, hexavalent
Aqueous/Solids	EPA 8015C	GC-FID	Gasoline range organics
Aqueous/Solids	EPA 8015C	GC-FID	Diesel range organics
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDD
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDE
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDT
Aqueous/Solids	EPA 8081B	GC-ECD	Aldrin
Aqueous/Solids	EPA 8081B	GC-ECD	α-BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Alpha-chlordane
Aqueous/Solids	EPA 8081B	GC-ECD	β-BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Chlordane, technical
Aqueous/Solids	EPA 8081B	GC-ECD	δ-BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Dieldrin
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan I
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan II
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan sulfate
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin aldehyde
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin ketone
Aqueous/Solids	EPA 8081B	GC-ECD	γ-BHC (Lindane)
Aqueous/Solids	EPA 8081B	GC-ECD	γ-Chlordane
Aqueous/Solids	EPA 8081B	GC-ECD	Heptachlor
Aqueous/Solids	EPA 8081B	GC-ECD	Heptachlor epoxide
Aqueous/Solids	EPA 8081B	GC-ECD	Hexachlorobenzene
Aqueous/Solids	EPA 8081B	GC-ECD	Methoxychlor
Aqueous/Solids	EPA 8081B	GC-ECD	Toxaphene
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1016
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1221
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1232
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1242
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1248
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1254

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Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1260
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1268
Aqueous/Solids	EPA 8151A	GC-ECD	2,4-D
Aqueous/Solids	EPA 8151A	GC-ECD	Dicamba
Aqueous/Solids	EPA 8151A	GC-ECD	2,4,5-T
Aqueous/Solids	EPA 8151A	GC-ECD	2,4,5-TP
Aqueous/Solids	EPA 8151A	GC-ECD	Pentachlorophenol (PCP)
Aqueous/Solids	EPA 8260C	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,1-Trichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2-Trichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,3-Trichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,3-Trichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,4-Trimethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dibromo-3-chloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dibromoethane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon-114)
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloro-1,1,2-trifluoroethane (Freon 123a)
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloroethene, total
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,3,5-Trimethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,3-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,3-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,4-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,4-Dioxane

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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8260C	GC-MS	2,2-Dichloro-1,1,1-trifluoroethane (Freon 123)
Aqueous/Solids	EPA 8260C	GC-MS	2,2-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	2-Butanone (MEK)
Aqueous/Solids	EPA 8260C	GC-MS	2-Chloro-1,3-butadiene
Aqueous/Solids	EPA 8260C	GC-MS	2-Chloroethylvinyl ether
Aqueous/Solids	EPA 8260C	GC-MS	2-Chlorotoluene
Aqueous/Solids	EPA 8260C	GC-MS	2-Hexanone
Aqueous/Solids	EPA 8260C	GC-MS	2-Methyl-1-propanol (Isobutlyl alcohol)
Aqueous/Solids	EPA 8260C	GC-MS	2-Methyl-2-propanol (Tertbutyl alcohol)
Aqueous/Solids	EPA 8260C	GC-MS	2-Nitropropane
Aqueous/Solids	EPA 8260C	GC-MS	2-Propanol
Aqueous/Solids	EPA 8260C	GC-MS	3-Chloro-1-propene (Allyl chloride)
Aqueous/Solids	EPA 8260C	GC-MS	4-Chlorotoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Ethyltoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Isopropyltoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous/Solids	EPA 8260C	GC-MS	Acetone
Aqueous/Solids	EPA 8260C	GC-MS	Acetonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Acrolein
Aqueous/Solids	EPA 8260C	GC-MS	Acrylonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Benzene
Aqueous/Solids	EPA 8260C	GC-MS	Benzyl chloride
Aqueous/Solids	EPA 8260C	GC-MS	Bromobenzene
Aqueous/Solids	EPA 8260C	GC-MS	Bromochloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Bromodichloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Bromoform
Aqueous/Solids	EPA 8260C	GC-MS	Bromomethane
Aqueous/Solids	EPA 8260C	GC-MS	Carbon disulfide
Aqueous/Solids	EPA 8260C	GC-MS	Carbon tetrachloride
Aqueous/Solids	EPA 8260C	GC-MS	Chlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	Chloroethane
Aqueous/Solids	EPA 8260C	GC-MS	Chloroform
Aqueous/Solids	EPA 8260C	GC-MS	Chloromethane

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Aqueous/Solids	EPA 8260C	GC-MS	cis-1,2-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	cis-1,3-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	Cyclohexane
Aqueous/Solids	EPA 8260C	GC-MS	Cyclohexanone
Aqueous/Solids	EPA 8260C	GC-MS	Dibromochloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Dibromomethane
Aqueous/Solids	EPA 8260C	GC-MS	Dichlorodifluoromethane (Freon 12)
Aqueous/Solids	EPA 8260C	GC-MS	Dichlorofluoromethane (Freon 21)
Aqueous/Solids	EPA 8260C	GC-MS	Dichloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Diethyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Diisopropyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Ethyl methacrylate
Aqueous/Solids	EPA 8260C	GC-MS	Ethyl tert-butyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Ethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Hexachlorobutadiene
Aqueous/Solids	EPA 8260C	GC-MS	Iodomethane
Aqueous/Solids	EPA 8260C	GC-MS	Isopropylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	m- + p-Xylene
Aqueous/Solids	EPA 8260C	GC-MS	Methacrylonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Methyl acetate
Aqueous/Solids	EPA 8260C	GC-MS	Methyl methacrylate
Aqueous/Solids	EPA 8260C	GC-MS	Methylcyclohexane
Aqueous/Solids	EPA 8260C	GC-MS	Methyl-tert-butyl ether (MTBE)
Aqueous/Solids	EPA 8260C	GC-MS	Napthalene
Aqueous/Solids	EPA 8260C	GC-MS	N-butylacetate
Aqueous/Solids	EPA 8260C	GC-MS	N-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	N-heptane
Aqueous/Solids	EPA 8260C	GC-MS	N-propylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	o-Xylene
Aqueous/Solids	EPA 8260C	GC-MS	Propionitrile
Aqueous/Solids	EPA 8260C	GC-MS	sec-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Styrene
Aqueous/Solids	EPA 8260C	GC-MS	tert-amyl methyl ether

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Aqueous/Solids	EPA 8260C	GC-MS	tert-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Tetra hydrofuran
Aqueous/Solids	EPA 8260C	GC-MS	Tetrachloroethene
Aqueous/Solids	EPA 8260C	GC-MS	Toluene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,2-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,3-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,4-Dichloro-2-butene
Aqueous/Solids	EPA 8260C	GC-MS	Trichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	Trichlorofluoromethane (Freon 11)
Aqueous/Solids	EPA 8260C	GC-MS	Vinyl acetate
Aqueous/Solids	EPA 8260C	GC-MS	Vinyl chloride
Aqueous/Solids	EPA 8260C	GC-MS	Xylenes, total
Aqueous/Solids	EPA 8270D	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2-Diphenylhydrazine
Aqueous/Solids	EPA 8270D	GC-MS	1,3,5-Trinitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,3-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,3-Dinitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Dioxane
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Naphthoquinone
Aqueous/Solids	EPA 8270D	GC-MS	1-Methyl-2-pyrrolidinone
Aqueous/Solids	EPA 8270D	GC-MS	1-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	1-Naphthylamine
Aqueous/Solids	EPA 8270D	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4,5-Trichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4,6-Trichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dimethylphenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dinitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dinitrotoluene
Aqueous/Solids	EPA 8270D	GC-MS	2,6-Dichlorophenol

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Columbia Analytical Services

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609
Lisa Reyes Phone: 585-288-5380

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS	2,6-Dinitrotoluene
Aqueous/Solids	EPA 8270D	GC-MS	2-Acetylaminofluorene
Aqueous/Solids	EPA 8270D	GC-MS	2-Chloronaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	2-Chlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Methyl-5-nitroaniline (5-Nitro-o-toluidine)
Aqueous/Solids	EPA 8270D	GC-MS	2-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	2-Methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Naphthylamine
Aqueous/Solids	EPA 8270D	GC-MS	2-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	2-Nitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Picoline
Aqueous/Solids	EPA 8270D	GC-MS	3,3'-Dichlorobenzidine
Aqueous/Solids	EPA 8270D	GC-MS	3,3'-Dimethylbenzidine
Aqueous/Solids	EPA 8270D	GC-MS	3+4-Methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	3-Methylcholanthrene
Aqueous/Solids	EPA 8270D	GC-MS	3-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4,6-Dinitro-2-methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Aminobiphenyl
Aqueous/Solids	EPA 8270D	GC-MS	4-Bromophenyl-phenylether
Aqueous/Solids	EPA 8270D	GC-MS	4-Chloro-3-methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Chloroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4-Chlorophenyl-phenylether
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitroquinoline-1-oxide
Aqueous/Solids	EPA 8270D	GC-MS	7,12-Dimethylbenz(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	α,α-Dimethylphenethylamine
Aqueous/Solids	EPA 8270D	GC-MS	Acenaphthene
Aqueous/Solids	EPA 8270D	GC-MS	Acenaphthylene
Aqueous/Solids	EPA 8270D	GC-MS	Acetophenone
Aqueous/Solids	EPA 8270D	GC-MS	Aniline
Aqueous/Solids	EPA 8270D	GC-MS	Anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Aramite

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Aqueous/Solids	EPA 8270D	GC-MS	Atrazine
Aqueous/Solids	EPA 8270D	GC-MS	Benzaldehyde
Aqueous/Solids	EPA 8270D	GC-MS	Benzidine
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(a)pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(b)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(k)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Benzoic acid
Aqueous/Solids	EPA 8270D	GC-MS	Benzyl alcohol
Aqueous/Solids	EPA 8270D	GC-MS	Biphenyl
Aqueous/Solids	EPA 8270D	GC-MS	Bis(1-chloroisopropyl)ether
Aqueous/Solids	EPA 8270D	GC-MS	Bis(-2-chloroethoxy)methane
Aqueous/Solids	EPA 8270D	GC-MS	Bis(2-chloroethyl)ether
Aqueous/Solids	EPA 8270D	GC-MS	Bis(2-ethylhexyl)phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Butyl benzyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Caprolactam
Aqueous/Solids	EPA 8270D	GC-MS	Carbazole
Aqueous/Solids	EPA 8270D	GC-MS	Chlorobenzilate
Aqueous/Solids	EPA 8270D	GC-MS	Chrysene
Aqueous/Solids	EPA 8270D	GC-MS	Cyclohexane, isothiocyanato-
Aqueous/Solids	EPA 8270D	GC-MS	Diallate
Aqueous/Solids	EPA 8270D	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Dibenzofuran
Aqueous/Solids	EPA 8270D	GC-MS	Diethylphthalate
Aqueous/Solids	EPA 8270D	GC-MS	Dimethoate
Aqueous/Solids	EPA 8270D	GC-MS	Dimethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Di-n-butylphthalate
Aqueous/Solids	EPA 8270D	GC-MS	Di-n-octyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Dinoseb
Aqueous/Solids	EPA 8270D	GC-MS	Diphenylamine
Aqueous/Solids	EPA 8270D	GC-MS	Disulfoton
Aqueous/Solids	EPA 8270D	GC-MS	Ethyl methanesulfonate

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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS	Fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Fluorene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorobutadiene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorocyclopentadiene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachloroethane
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorophene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachloropropene
Aqueous/Solids	EPA 8270D	GC-MS	Indeno(1,2,3-cd)pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Isodrin
Aqueous/Solids	EPA 8270D	GC-MS	Isophorone
Aqueous/Solids	EPA 8270D	GC-MS	Isosafrole
Aqueous/Solids	EPA 8270D	GC-MS	Methapyrilene
Aqueous/Solids	EPA 8270D	GC-MS	Methyl methanesulfonate
Aqueous/Solids	EPA 8270D	GC-MS	Methyl parathion
Aqueous/Solids	EPA 8270D	GC-MS	Naphthalene
Aqueous/Solids	EPA 8270D	GC-MS	Nitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodiethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodimethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodi-n-butylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitroso-di-n-propylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodiphenylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosomethylethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosomorpholine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosopiperidine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosopyrolidine
Aqueous/Solids	EPA 8270D	GC-MS	Octachlorostyrene
Aqueous/Solids	EPA 8270D	GC-MS	o,o,o-triethyl phosphorothioate
Aqueous/Solids	EPA 8270D	GC-MS	o-toluidine
Aqueous/Solids	EPA 8270D	GC-MS	Parathion (ethyl)
Aqueous/Solids	EPA 8270D	GC-MS	p-dimethylaminoazobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachloroethane

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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS	Pentachloronitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	Phenacetin
Aqueous/Solids	EPA 8270D	GC-MS	Phenanthrene
Aqueous/Solids	EPA 8270D	GC-MS	Phenol
Aqueous/Solids	EPA 8270D	GC-MS	Phorate
Aqueous/Solids	EPA 8270D	GC-MS	Phthalimide
Aqueous/Solids	EPA 8270D	GC-MS	Pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Pyridine
Aqueous/Solids	EPA 8270D	GC-MS	Safrole
Aqueous/Solids	EPA 8270D	GC-MS	Sulfotepp
Aqueous/Solids	EPA 8270D	GC-MS	Thionazin
Aqueous/Solids	EPA 8270D	GC-MS-LL	1,4-Dioxane
Aqueous/Solids	EPA 8270D	GC-MS-LL	1-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	2-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Acenaphthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Acenaphthylene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(a)pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(b)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(g,h,i)perylene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(k)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Bis(2-ethylhexyl)phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Butyl benzyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Carbazole
Aqueous/Solids	EPA 8270D	GC-MS-LL	Chrysene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dibenzo(a,h)anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dibenzofuran
Aqueous/Solids	EPA 8270D	GC-MS-LL	Diethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dimethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Di-n-butyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Di-n-octyl phthalate

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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS-LL	Fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Fluorene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Hexachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Indeno(1,2,3-cd)pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Naphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Nitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Octachlorostyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Phenanthrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Pyridine
Aqueous/Solids	EPA 9012A, B	UV-VIS	Cyanide, total
Aqueous/Solids	EPA 9034	Titration	Sulfide, acid soluble
Aqueous/Solids	EPA 9056A	IC	Bromide
Aqueous/Solids	EPA 9056A	IC	Chloride
Aqueous/Solids	EPA 9056A	IC	Fluoride
Aqueous/Solids	EPA 9056A	IC	Nitrate as Nitrogen
Aqueous/Solids	EPA 9056A	IC	Nitrite as Nitrogen
Aqueous/Solids	EPA 9056A	IC	Sulfate
Aqueous/Solids	GEN-AVS	Titrimetric	Acid Volatile Sulfide
Aqueous/Solids	EPA 8330B	HPLC	1,3,5-Trinitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	1,3-Dinitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	2,4,6-Trinitrotoluene (TNT)
Aqueous/Solids	EPA 8330B	HPLC	2,4-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2-Amino 4,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	3,5-Dinitroaniline
Aqueous/Solids	EPA 8330B	HPLC	3-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	4-Amino 2,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	4-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	Hexahydro 1,3,5-Trinitro 1,3,5-Triazine
Aqueous/Solids	EPA 8330B	HPLC	Methyl 2,4,6 Trinitrophenylnitramine
Aqueous/Solids	EPA 8330B	HPLC	Nitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	Nitroglycerin

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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8330B	HPLC	Octahydro 1.3.5.7 Tetranitro 1,3,5,7 Tetraz
Aqueous/Solids	EPA 8330B	HPLC	Pentaerythritol Tetranitrate (PETN)
Aqueous/Solids	HPLC-METACID	HPLC	Acetic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Butanoic Acid (Butyric Acid)
Aqueous/Solids	HPLC-METACID	HPLC	Lactic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Propionic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Pyruvic Acid

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 3010A	Acid Digestion	Metals prep
Aqueous	EPA 3510C	SF Extraction	Semivolatiles, pesticides, PCBs, DRO
Aqueous	EPA 5030B	P&T	Volatiles
Solids	EPA 3050B	Acid Digestion	Metals prep
Solids	EPA 3060A	Digestion	Hexavalent chromium digestion
Solids	EPA 3541	SOX Extraction	Semivolatiles, pesticides, PCBs, DRO
Solids	EPA 5035	P&T closed	Volatiles
Aqueous/Solids	EPA 1311	TCLP	Physical Extraction
Aqueous/Solids	EPA 1312	SPLP	Physical Extraction
Aqueous/Solids	EPA 3620B	Florisil Cleanup	Semivolatiles, pesticides, PCBs
Aqueous/Solids	EPA 3660B	Sulfur Cleanup	Semivolatiles, pesticides, PCBs
Aqueous/Solids	EPA 3665A	Sulfuric Acid Cleanup	PCBs
Aqueous/Solids	EPA 9012A, B	Distillation	Cyanide
Aqueous/Solids	EPA 9030B	Distillation	Sulfide, acid soluble

APPENDIX D

LIST OF USEPA AND FDEP SCREENING CRITERIA

Chemical	CAS No.	GCTL (ug/L)	EPA Tapwater (ug/L)	Basis	Adjusted EPA Tapwater RSL (ug/L)	Minimum	Minimum PAL Reference
TAL Metals							
ALUMINUM	7429-90-5	200	16000	n	1600	200	GCTL
ANTIMONY	7440-36-0	6	6	n	0.6	0.6	Tapwater RSL
ARSENIC	7440-38-2	10	0.045	c	0.045	0.045	Tapwater RSL
BARIUM	7440-39-3	2000	2900	n	290	290	Tapwater RSL
BERYLLIUM	7440-41-7	4	16	n	1.6	1.6	Tapwater RSL
CADMIUM	7440-43-9	5	6.9	n	0.69	0.69	Tapwater RSL
CALCIUM	7440-70-2	NC	NC	NC	NC	None	None
CHROMIUM	7440-47-3	100	0.031	c	0.031	0.031	Tapwater RSL
COBALT	7440-48-4	140	4.7	n	0.47	0.47	Tapwater RSL
COPPER	7440-50-8	1000	620	n	62	62	Tapwater RSL
IRON	7439-89-6	300	11000	n	1100	300	GCTL
LEAD	7439-92-1	15	15	n	15	15	GCTL/Tapwater RSL
MERCURY	7439-97-6	2	0.63	n	0.063	0.063	Tapwater RSL
MAGNESIUM	7439-95-4	NC	NC	NC	NC	None	None
MANGANESE	7439-96-5	50	320	n	32	32	Tapwater RSL
NICKEL	7440-02-0	100	300	n	30	30	Tapwater RSL
POTASSIUM	7440-09-7	NC	NC	NC	NC	None	None
SELENIUM	7782-49-2	50	78	n	7.8	7.8	Tapwater RSL
SILVER	7440-22-4	100	71	n	7.1	7.1	Tapwater RSL
SODIUM	7440-23-5	160000	NC	NC	NC	160000	GCTL
THALLIUM	7440-28-0	2	0.16	n	0.016	0.016	Tapwater RSL
VANADIUM	7440-62-2	49	78	n	7.8	7.8	Tapwater RSL
ZINC	7440-66-6	5000	4700	n	470	470	Tapwater RSL
TCL VOCs							
1,1-DICHLOROETHANE	75-34-3	70	2.4	c	2.4	2.4	Tapwater RSL
1,1,1-TRICHLOROETHANE	71-55-6	200	7500	n	750	200	GCTL
1,1,2-TRICHLOROETHANE	79-00-5	5	0.41	n	0.041	0.041	Tapwater RSL
1,1,2,2-TETRACHLOROETHANE	79-34-5	0.2	0.066	c	0.066	0.066	Tapwater RSL
1,1,2-TRICHLORO-1,2,2-TRIFLUORO-E	76-13-1	210000	53000	n	5300	5300	Tapwater RSL
1,1-DICHLOROETHENE	75-35-4	7	260	n	26	7	GCTL
1,2-DICHLOROBENZENE	95-50-1	600	280	n	28	28	Tapwater RSL
1,2-DICHLOROETHANE	107-06-2	3	0.15	c*	0.15	0.15	Tapwater RSL
1,2,3-TRICHLOROBENZENE	87-61-6	70	5.2	n	0.52	0.52	Tapwater RSL
1,2,4-TRICHLOROBENZENE	120-82-1	70	3.9	n	0.39	0.39	Tapwater RSL
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.2	0.00032	c	0.00032	0.00032	Tapwater RSL
1,2-DIBROMOETHANE	106-93-4	0.02	0.0065	c	0.0065	0.0065	Tapwater RSL
1,2-DICHLOROPROPANE	78-87-5	5	0.38	c*	0.38	0.38	Tapwater RSL
1,3-DICHLOROBENZENE	541-73-1	210	NC	nc	NC	210	GCTL
1,4-DICHLOROBENZENE	106-46-7	75	0.42	c	0.42	0.42	Tapwater RSL
1,4-DIOXANE	123-91-1	3.2	0.67	c	0.67	0.67	Tapwater RSL
2-BUTANONE	78-93-3	4200	4900	n	490	490	Tapwater RSL

ALUMINUM	7429-90-5	200	16000	n	1600	200	GCTL
2-HEXANONE	591-78-6	280	34	n	3.4	3.4	Tapwater RSL
4-METHYL-2-PENTANONE	108-10-1	560	1000	n	100	100	Tapwater RSL
ACETONE	67-64-1	6300	12000	n	1200	1200	Tapwater RSL
BENZENE	71-43-2	1	0.39	c*	0.39	0.39	Tapwater RSL
BROMOCHLOROMETHANE	74-97-5	91	83	n	8.3	8.3	Tapwater RSL
BROMODICHLOROMETHANE	75-27-4	0.6	0.12	c	0.12	0.12	Tapwater RSL
BROMOFORM	75-25-2	4.4	7.9	c*	7.9	4.4	GCTL
BROMOMETHANE	74-83-9	9.8	7	n	0.7	0.7	Tapwater RSL
CARBON DISULFIDE	75-15-0	700	720	n	72	72	Tapwater RSL
CARBON TETRACHLORIDE	56-23-5	3	0.39	c	0.39	0.39	Tapwater RSL
CHLOROBENZENE	108-90-7	100	72	n	7.2	7.2	Tapwater RSL
CHLOROETHANE	75-00-3	12	21000	n	2100	12	GCTL
CHLOROFORM	67-66-3	70	0.19	c	0.19	0.19	Tapwater RSL
CHLOROMETHANE	74-87-3	2.7	190	n	19	2.7	GCTL
CIS-1,2-DICHLOROETHENE	156-59-2	70	28	n	2.8	2.8	Tapwater RSL
CIS-1,3-DICHLOROPROPENE	10061-01-5	NC	0.41	c	0.41	0.41	Tapwater RSL
CYCLOHEXANE	110-82-7	NC	13000	n	1300	1300	Tapwater RSL
DIBROMOCHLOROMETHANE	124-48-1	0.4	0.15	c	0.15	0.15	Tapwater RSL
DICHLORODIFLUOROMETHANE	75-71-8	1400	190	n	19	19	Tapwater RSL
ETHYLBENZENE	100-41-4	30	1.3	c	1.3	1.3	Tapwater RSL
ISOPROPYLBENZENE	98-82-8	0.8	390	n	39	0.8	GCTL
METHYL ACETATE	79-20-9	3000	16000	n	1600	1600	Tapwater RSL
METHYL TERT-BUTYL ETHER	1634-04-4	20	12	c	12	12	Tapwater RSL
METHYL CYCLOHEXANE	108-87-2	NC	NC	nc	NC	NC	None
METHYLENE CHLORIDE	75-09-2	5	4.7	c	4.7	4.7	Tapwater RSL
STYRENE	100-42-5	100	1100	n	110	100	Tapwater RSL
TETRACHLOROETHENE	127-18-4	3	0.072	c	0.072	0.072	Tapwater RSL
TOLUENE	108-88-3	40	860	n	86	40	GCTL
O-XYLENE	95-94-6	NC	190	n	19	19	Tapwater RSL
m,p-XYLENE	179601-23-1	NC	190	n	19	19	Tapwater RSL
TOTAL XYLENES	1330-20-7	20	190	n	19	19	Tapwater RSL
TRANS-1,2-DICHLOROETHENE	156-60-5	100	86	n	8.6	8.6	Tapwater RSL
TRANS-1,3-DICHLOROPROPENE	10061-02-6	NC	0.41	c	0.41	0.41	Tapwater RSL
TRICHLOROETHENE	79-01-6	3	2.6	n	0.26	0.26	Tapwater RSL
TRICHLOROFLUOROMETHANE	75-69-4	2100	1100	n	110	110	Tapwater RSL
VINYL CHLORIDE	75-01-4	1	0.015	c	0.015	0.015	Tapwater RSL
TCL SVOCs							
1,1'-BIPHENYL	92-52-4	0.5	0.83	n	0.083	0.083	Tapwater RSL
1,2,4,5-TETRACHLOROBENZENE	95-94-3	2.1	1.2	n	0.12	0.12	Tapwater RSL
2,2-OXYBIS(1-CHLOROPROPANE)	108-60-1	0.5	0.31	c	0.31	0.31	Tapwater RSL
2,3,4,6-TETRACHLOROPHENOL	58-90-2	210	170	n	17	17	Tapwater RSL
2,4,5-TRICHLOROPHENOL	95-95-4	1	890	n	89	1	GCTL
2,4,6-TRICHLOROPHENOL	88-06-2	3.2	9	n	0.9	0.9	Tapwater RSL
2,4-DICHLOROPHENOL	120-83-2	0.3	35	n	3.5	0.3	GCTL

ALUMINUM	7429-90-5	200	16000	n	1600	200	GCTL
2,4-DIMETHYLPHENOL	105-67-9	140	270	n	27	27	Tapwater RSL
2,4-DINITROPHENOL	51-28-5	14	30	n	3	3	Tapwater RSL
2,4-DINITROTOLUENE	121-14-2	0.05	0.2	c	0.2	0.05	GCTL
2,6-DINITROTOLUENE	606-20-2	0.05	15	n	1.5	0.05	GCTL
2-CHLORONAPHTHALENE	91-58-7	560	550	n	55	55	Tapwater RSL
2-CHLOROPHENOL	95-57-8	35	71	n	7.1	7.1	Tapwater RSL
2-METHYLNAPHTHALENE	91-57-6	28	27	n	2.7	2.7	Tapwater RSL
2-METHYLPHENOL	95-48-7	35	720	n	72	35	GCTL
2-NITROANILINE	88-74-4	21	150	n	15	15	Tapwater RSL
2-NITROPHENOL	88-75-5	NC	NC	NC	NC	NC	None
3,3'-DICHLOROBENZIDINE	91-94-1	0.08	0.11	c	0.11	0.08	GCTL
3-NITROANILINE	99-09-2	1.7	3.3	c	3.3	1.7	GCTL
4,6-DINITRO-2-METHYLPHENOL	534-52-1	NC	1.2	n	0.12	0.12	Tapwater RSL
4-BROMOPHENYL-PHENYLETHER	101-55-3	NC	NC	NC	NC	NC	None
4-CHLORO-3-METHYLPHENOL	59-50-7	63	1100	n	110	63	GCTL
4-CHLOROANILINE	106-47-8	28	0.32	c	0.32	0.32	Tapwater RSL
4-CHLOROPHENYL-PHENYL ETHER	7005-72-3	NC	NC	NC	NC	NC	None
4-METHYLPHENOL	106-44-5	3.5	72	n	7.2	3.5	GCTL
4-NITROANILINE	100-01-6	1.7	3.3	c*	3.3	1.7	GCTL
4-NITROPHENOL	100-02-7	56	NC	NC	NC	56	GCTL
ACENAPHTHENE	83-32-9	20	400	n	40	20	GCTL
ACENAPHTHYLENE	208-96-8	210	400	n	40	40	Tapwater RSL
ANTHRACENE	120-12-7	2100	1300	n	130	130	Tapwater RSL
ATRAZINE	1912-24-9	3	0.26	c	0.26	0.26	Tapwater RSL
BENZALDEHYDE	100-52-7	700	1500	n	150	150	Tapwater RSL
BENZO(A)ANTHRACENE	56-55-3	0.05	0.029	c	0.029	0.029	Tapwater RSL
BENZO(A)PYRENE	50-32-8	0.2	0.0029	c	0.0029	0.0029	Tapwater RSL
BENZO(B)FLUORANTHENE	205-99-2	0.05	0.029	c	0.029	0.029	Tapwater RSL
BENZO(G,H,I)PERYLENE	191-24-2	210	87	n	8.7	8.7	Tapwater RSL
BENZO(K)FLUORANTHENE	207-08-9	0.5	0.29	c	0.29	0.29	Tapwater RSL
BIS(2-CHLOROETHOXY)METHANE	111-91-1	NC	47	n	4.7	4.7	Tapwater RSL
BIS(2-CHLOROETHYL)ETHER	111-44-4	0.03	0.012	c	0.012	0.012	Tapwater RSL
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	6	0.071	c*	0.071	0.071	Tapwater RSL
BUTYLBENZYLPHTHALATE	85-68-7	140	14	c*	14	14	Tapwater RSL
CAPROLACTAM	105-60-2	NC	7700	n	770	770	Tapwater RSL
CARBAZOLE	86-74-8	1.8	NC	NC	NC	1.8	GCTL
CHRYSENE	218-01-9	4.8	2.9	c	2.9	2.9	Tapwater RSL
DIBENZO(A,H)ANTHRACENE	53-70-3	0.005	0.0029	c	0.0029	0.0029	Tapwater RSL
DIBENZOFURAN	132-64-9	28	5.8	n	0.58	0.58	Tapwater RSL
DIETHYL PHTHALATE	84-66-2	5600	11000	n	1100	1100	Tapwater RSL
DIMETHYL PHTHALATE	131-11-3	70000	NC	NC	NC	70000	GCTL
DI-N-BUTYL PHTHALATE	84-74-2	700	670	n	67	67	Tapwater RSL
DI-N-OCTYL PHTHALATE	117-84-0	140	NC	NC	NC	140	GCTL
FLUORANTHENE	206-44-0	280	630	n	63	63	Tapwater RSL

ALUMINUM	7429-90-5	200	16000	n	1600	200	GCTL
FLUORENE	86-73-7	280	220	n	22	22	Tapwater RSL
HEXACHLOROBENZENE	118-74-1	1	0.042	c	0.042	0.042	Tapwater RSL
HEXACHLOROBUTADIENE	87-68-3	0.4	0.26	c*	0.26	0.26	Tapwater RSL
HEXACHLOROCYCLOPENTADIENE	77-47-4	50	22	n	2.2	2.2	Tapwater RSL
HEXACHLOROETHANE	67-72-1	2.5	5.1	n	0.51	0.51	Tapwater RSL
INDENO(1,2,3-CD)PYRENE	193-39-5	0.05	0.029	c	0.029	0.029	Tapwater RSL
ISOPHORONE	78-59-1	37	67	c*	67	37	GCTL
NAPHTHALENE	91-20-3	14	0.14	c*	0.14	0.14	Tapwater RSL
NITROBENZENE	98-95-3	3.5	0.12	c*	0.12	0.12	Tapwater RSL
N-NITROSODIPHENYLAMINE	86-30-6	7.1	10	c	10	7.1	GCTL
N-NITROSO-DI-N-PROPYLAMINE	621-64-7	0.005	0.0093	c	0.0093	0.005	GCTL
PENTACHLOROPHENOL	87-86-5	1	0.17	c	0.17	0.17	Tapwater RSL
PHENANTHRENE	85-01-8	210	87	n	8.7	8.7	Tapwater RSL
PHENOL	108-95-2	10	4500	n	450	10	GCTL
PYRENE	129-00-0	210	87	n	8.7	8.7	Tapwater RSL
TCL Pesticides							
4,4'-DDD	72-54-8	0.1	0.28	c	0.28	0.1	GCTL
4,4'-DDE	72-55-9	0.1	0.2	c	0.2	0.1	GCTL
4,4'-DDT	50-29-3	0.1	0.2	c*	0.2	0.1	GCTL
ALDRIN	309-00-2	0.002	0.00021	c	0.00021	0.00021	Tapwater RSL
ALPHA-BHC	319-84-6	0.006	0.0062	c	0.0062	0.006	GCTL
ALPHA-CHLORDANE	5103-71-9	NC	0.19	c	0.19	0.19	Tapwater RSL
BETA-BHC	319-85-7	0.02	0.022	c	0.022	0.02	GCTL
DELTA-BHC	319-86-8	2.1	NC	NC	NC	2.1	GCTL
DIELDRIN	60-57-1	0.002	0.0015	c	0.0015	0.0015	Tapwater RSL
ENDOSULFAN I	959-98-8	NC	78	n	0.78	0.78	Tapwater RSL
ENDOSULFAN II	33213-65-9	NC	78	n	0.78	0.78	Tapwater RSL
ENDOSULFAN SULFATE	1031-07-8	NC	78	n	0.78	0.78	Tapwater RSL
ENDRIN	72-20-8	2	1.7	n	0.17	0.17	Tapwater RSL
ENDRIN ALDEHYDE	7421-93-4	NC	1.7	n	0.17	0.17	Tapwater RSL
ENDRIN KETONE	53494-70-5	NC	1.7	n	0.17	0.17	Tapwater RSL
GAMMA-BHC (LINDANE)	58-89-9	0.2	0.036	c*	0.036	0.036	Tapwater RSL
GAMMA-CHLORDANE	5103-74-2	NC	0.19	c	0.19	0.19	Tapwater RSL
HEPTACHLOR	76-44-8	0.4	0.0018	c	0.0018	0.0018	Tapwater RSL
HEPTACHLOR EPOXIDE	1024-57-3	0.2	0.0033	c*	0.0033	0.0033	Tapwater RSL
METHOXYCHLOR	72-43-5	40	27	n	2.7	2.7	Tapwater RSL
TOXAPHENE	8001-35-2	3	0.013	c	0.013	0.013	Tapwater RSL
TCL PCBs							
AROCLOR-1016	12674-11-2	NC	1.1	n	0.11	0.11	Tapwater RSL
AROCLOR-1221	11104-28-2	NC	0.0043	c	0.0043	0.0043	Tapwater RSL
AROCLOR-1232	11141-16-5	NC	0.0043	c	0.0043	0.0043	Tapwater RSL
AROCLOR-1242	53469-21-9	NC	0.034	c	0.034	0.034	Tapwater RSL
AROCLOR-1248	12672-29-6	NC	0.034	c	0.034	0.034	Tapwater RSL
AROCLOR-1254	11097-69-1	NC	0.31	n	0.031	0.031	Tapwater RSL

ALUMINUM	7429-90-5	200	16000	n	1600	200	GCTL
AROCLOR-1260	11096-82-5	NC	0.034	c	0.034	0.034	Tapwater RSL
TOTAL AROCLOR	1336-36-3	0.5	NC	NC	NC	0.5	GCTL

Notes:
1) The value for hexa valent chromium is presented
2) The value presented is for Vanadium and compounds.
3) The value for 1,3-dichloropropene is presented.
4) The value for 4-nitroaniline is presented.
5) The value for acenaphthene is presented.
6) The value for pyrene is presented.
7) The value for Chlordane is presented.
8) The value for Endosulfan is presented.
9) The value for Endrin is presented.
The USEPA RSL (June, 2011) tap water RSLs for noncarcinogens adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The tap water RSL for carcinogens (not adjusted) is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

Chemical	CAS No.	Residential SCTL (mg/kg)	Industrial SCTL (mg/kg)	Leachability Based on Groundwater (mg/kg)	EPA Residential Soil Direct Contact (mg/kg)	Basis	Adjusted EPA Residential Soil Direct Contact (mg/kg)	EPA Migration to GW DAF 1 (mg/kg)	EPA Migration to GW DAF 20 (mg/kg)	PAL (mg/kg) Minimum	PAL Reference
TAL Metals											
ALUMINUM	7429-90-5	80000	NC	NC	77000	n	7700	23000	460000	7700	EPA RSL
ANTIMONY	7440-36-0	27	370	5.4	31	n	3.1	0.27	5.4	3.1	EPA RSL
ARSENIC	7440-38-2	2.1	12	NC	0.39	c*	0.39	0.0013	0.026	0.026	EPA Migration to GW
BARIUM	7440-39-3	120	130000	1600	15000	n	1500	120	2400	120	Residential SCTL
BERYLLIUM	7440-41-7	120	1400	63	160	n	16	13	260	16	EPA RSL
CADMIUM	7440-43-9	82	1700	7.5	70	n	7	NC	NC	7	EPA RSL
CALCIUM	7440-70-2	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
CHROMIUM	7440-47-3	210	470	38	0.29	c	0.29	0.00059	0.0118	0.0118	EPA Migration to GW
COBALT	7440-48-4	1700	42000	NC	23	n	2.3	0.21	4.2	2.3	EPA RSL
COPPER	7440-50-8	150	89000	NC	3100	n	310	22	440	150	Residential SCTL
IRON	7439-89-6	53000	NC	NC	55000	n	5500	270	5400	5400	EPA Migration to GW
LEAD	7439-92-1	400	1400	NC	400	n	400	NC	NC	400	EPA RSL
MERCURY	7439-97-6	3	17	2.1	10	n	1	0.033	0.66	0.66	EPA Migration to GW
MAGNESIUM	7439-95-4	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
MANGANESE	7439-96-5	3500	43000	NC	1800	n	180	21	420	180	EPA RSL
NICKEL	7440-02-0	340	35000	130	1500	n	150	20	400	130	Leachability SCTL
POTASSIUM	7440-09-7	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
SELENIUM	7782-49-2	440	11000	5.2	390	n	39	0.4	8	5.2	Leachability SCTL
SILVER	7440-22-4	410	8200	17	390	n	39	0.6	12	12	EPA Migration to GW
SODIUM	7440-23-5	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
THALLIUM	7440-28-0	6.1	150	2.8	0.78	n	0.078	0.011	0.22	0.078	EPA RSL
VANADIUM	7440-62-2	67	10000	980	390	n	39	78	1560	39	EPA RSL
ZINC	7440-66-6	26000	630000	NC	23000	n	2300	290	5800	2300	EPA RSL
TCL VOCs											
1,1- DICHLOROETHANE	75-34-3	390	2100	0.4	3.3	c	3.3	0.00068	0.0136	0.0136	EPA Migration to GW
1,1,1-TRICHLOROETHANE	71-55-6	730	3900	1.9	8700	n	870	2.6	52	1.9	Leachability SCTL
1,1,2- TRICHLOROETHANE	79-00-5	1.4	2	0.03	1.1	c**	1.1	0.000077	0.00154	0.00154	EPA Migration to GW
1,1,2,2- TETRACHLORETHANE	79-34-5	0.7	1.2	0.001	0.56	c	0.56	0.000026	0.00052	0.00052	EPA Migration to GW
1,1,2-TRICHLORO-1,2,2-TRIFLUORO-ETHANE	76-13-1	18000	96000	11000	43000	n	4300	130	2600	2600	EPA Migration to GW
1,1-DICHLOROETHENE	75-35-4	95	510	0.06	240	n	24	0.093	1.86	0.06	Leachability SCTL
1,2- DICHLOROBENZENE	95-50-1	880	5000	17	1900	n	190	0.27	5.4	5.4	EPA Migration to GW
1,2- DICHLOROETHANE	107-06-2	0.5	0.7	0.01	0.43	c*	0.43	0.000042	0.00084	0.00084	EPA Migration to GW
1,2,3-TRICHLOROBENZENE	87-61-6	650	8200	4.6	49	n	4.9	0.015	0.3	0.3	EPA Migration to GW
1,2,4-TRICHLOROBENZENE	120-82-1	660	8500	5.3	22	c**	22	0.0029	0.058	0.058	EPA Migration to GW
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.7	3.8	0.001	0.0054	c	0.0054	0.00000014	0.0000028	0.0000028	EPA Migration to GW
1,2-DIBROMOETHANE	106-93-4	0.1	0.2	0.0001	0.034	c	0.034	0.0000018	0.000036	0.000036	EPA Migration to GW
1,2-DICHLOROPROPANE	78-87-5	0.6	0.9	0.03	0.94	c*	0.94	0.00013	0.0026	0.0026	EPA Migration to GW
1,3-DICHLOROBENZENE	541-73-1	380	2200	7	NC	c	NC	NC	NC	7	Leachability SCTL
1,4- DICHLOROBENZENE	106-46-7	6.4	9.9	2.2	2.4	c	2.4	0.0004	0.008	0.008	EPA Migration to GW
1,4-DIOXANE	123-91-1	23	38	0.01	4.9	c	4.9	0.00014	0.0028	0.0028	EPA Migration to GW
2-BUTANONE	78-93-3	16000	110000	17	28000	n	2800	1	20	17	Leachability SCTL
2-HEXANONE	591-78-6	24	130	1.4	210	n	21	0.0079	0.158	0.158	EPA Migration to GW
4-METHYL-2-PENTANONE	108-10-1	4300	44000	2.6	5300	n	530	0.23	4.6	2.6	Leachability SCTL
ACETONE	67-64-1	11000	68000	25	61000	n	6100	2.4	48	25	Leachability SCTL
BENZENE	71-43-2	1.2	1.7	0.007	1.1	c*	1.1	0.0002	0.004	0.004	EPA Migration to GW
BROMOCHLOROMETHANE	74-97-5	95	530	0.6	160	n	16	0.021	0.42	0.42	EPA Migration to GW
BROMODICHLOROMETHANE	75-27-4	1.5	2.2	0.004	0.27	c	0.27	0.000032	0.00064	0.00064	EPA Migration to GW
BROMOFORM	75-25-2	48	93	0.03	62	c*	62	0.0021	0.042	0.03	Leachability SCTL
BROMOMETHANE	74-83-9	3.1	16	0.05	7.3	n	0.73	0.0018	0.036	0.036	EPA Migration to GW
CARBON DISULFIDE	75-15-0	270	1500	5.6	820	n	82	0.21	4.2	4.2	EPA Migration to GW
CARBON TETRACHLORIDE	56-23-5	0.5	0.7	0.04	0.61	c	0.61	0.00015	0.003	0.003	EPA Migration to GW
CHLOROBENZENE	108-90-7	120	650	1.3	290	n	29	0.049	0.98	0.98	EPA Migration to GW
CHLOROETHANE	75-00-3	3.9	5.4	0.06	15000	n	1500	5.9	118	0.06	Leachability SCTL
CHLOROFORM	67-66-3	0.4	0.6	0.4	0.29	c	0.29	0.000053	0.00106	0.00106	EPA Migration to GW
CHLOROMETHANE	74-87-3	4	5.7	0.01	120	n	12	0.049	0.98	0.01	Leachability SCTL
CIS-1,2- DICHLOROETHENE	156-59-2	33	180	0.4	160	n	16	0.0082	0.164	0.164	EPA Migration to GW
CIS-1,3- DICHLOROPROPENE	10061-01-5	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
CYCLOHEXANE	110-82-7	NC	NC	NC	7000	n	700	13	260	260	EPA Migration to GW
DIBROMOCHLOROMETHANE	124-48-1	1.5	2.3	0.003	0.68	c	0.68	0.000039	0.00078	0.00078	EPA Migration to GW
DICHLORODIFLUOROMETHANE	75-71-8	77	410	44	94	n	9.4	0.3	6	6	EPA Migration to GW
ETHYLBENZENE	100-41-4	1500	9200	0.6	5.4	c	5.4	0.0015	0.03	0.03	EPA Migration to GW
ISOPROPYLBENZENE	98-82-8	220	1200	0.2	2100	n	210	0.64	12.8	0.2	Leachability SCTL
METHYL ACETATE	79-20-9	6800	38000	16	78000	n	7800	3.2	64	16	Leachability SCTL
METHYL TERT-BUTYL ETHER	1634-04-4	4400	24000	0.09	43	c	43	0.0028	0.056	0.056	EPA Migration to GW
METHYLCYCLOHEXANE	108-87-2	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
METHYLENE CHLORIDE	75-09-2	17	26	0.02	11	c	11	0.0012	0.024	0.02	Leachability SCTL
STYRENE	100-42-5	3600	23000	3.6	6300	n	630	1.2	24	3.6	Leachability SCTL
TETRACHLOROETHENE	127-18-4	8.8	18	0.03	0.55	c	0.55	0.000033	0.00066	0.00066	EPA Migration to GW
TOLUENE	108-88-3	7500	60000	0.5	5000	n	500	0.59	11.8	0.5	Leachability SCTL
TOTAL XYLENES	1330-20-7	130	700	0.2	630	n	63	0.19	3.8	0.2	Leachability SCTL

Chemical	CAS No.	Residential SCTL (mg/kg)	Industrial SCTL (mg/kg)	Leachability Based on Groundwater (mg/kg)	EPA Residential Soil Direct Contact (mg/kg)	Basis	Adjusted EPA Residential Soil Direct Contact (mg/kg)	EPA Migration to GW DAF 1 (mg/kg)	EPA Migration to GW DAF 20 (mg/kg)	PAL (mg/kg) Minimum	PAL Reference
TRANS-1,2- DICHLOROETHENE	156-60-5	53	290	0.7	150	n	15	0.025	0.5	0.5	EPA Migration to GW
TRANS-1,3-DICHLOROPROPENE	10061-02-6	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
TRICHLOROETHENE	79-01-6	6.4	9.3	0.03	0.91	c**	0.91	0.00016	0.0032	0.0032	EPA Migration to GW
TRICHLOROFLUOROMETHANE	75-69-4	270	1500	33	790	n	79	0.69	13.8	13.8	EPA Migration to GW
VINYL CHLORIDE	75-01-4	0.2	0.8	0.007	0.06	c	0.06	0.0000053	0.000106	0.000106	EPA Migration to GW
TCL SVOCs											
1,1'-BIPHENYL	92-52-4	3000	34000	0.2	51	n	5.1	0.0087	0.174	0.174	EPA Migration to GW
1,2,4,5-TETRACHLOROBENZENE	95-94-3	12	100	0.5	18	n	1.8	0.0058	0.116	0.116	EPA Migration to GW
2,2-OXYBIS(1-CHLOROPROPANE)	108-60-1	6	12	0.009	4.6	c	4.6	0.00011	0.0022	0.0022	EPA Migration to GW
2,3,4,6-TETRACHLOROPHENOL	58-90-2	2100	30000	3.2	1800	n	180	1.1	22	3.2	Leachability SCTL
2,4,5-TRICHLOROPHENOL	95-95-4	7700	130000	0.07	6100	n	610	3.3	66	0.07	Leachability SCTL
2,4,6-TRICHLOROPHENOL	88-06-2	70	230	0.06	44	c**	44	0.013	0.26	0.06	Leachability SCTL
2,4-DICHLOROPHENOL	120-83-2	190	2400	0.003	180	n	18	0.041	0.82	0.003	Leachability SCTL
2,4-DIMETHYLPHENOL	105-67-9	1300	18000	1.7	1200	n	120	0.32	6.4	1.7	Leachability SCTL
2,4-DINITROPHENOL	51-28-5	110	1200	0.06	120	n	12	0.034	0.68	0.06	Leachability SCTL
2,4-DINITROTOLUENE	121-14-2	1.2	4.3	0.0004	1.6	c*	1.6	0.00028	0.0056	0.0004	Leachability SCTL
2,6-DINITROTOLUENE	606-20-2	1.2	3.8	0.0004	61	n	6.1	0.02	0.4	0.0004	Leachability SCTL
2-CHLORONAPHTHALENE	91-58-7	5000	61000	260	6300	n	630	2.9	58	58	EPA Migration to GW
2-CHLOROPHENOL	95-57-8	130	860	0.7	390	n	39	0.057	1.14	0.7	Leachability SCTL
2-METHYLNAPHTHALENE	91-57-6	210	2100	8.5	310	n	31	0.14	2.8	2.8	EPA Migration to GW
2-METHYLPHENOL	95-48-7	2900	31000	0.3	3100	n	310	0.58	11.6	0.3	Leachability SCTL
2-NITROANILINE	88-74-4	24	130	0.1	610	n	61	0.062	1.24	0.1	Leachability SCTL
2-NITROPHENOL	88-75-5	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
3,3'-DICHLOROBENZIDINE	91-94-1	2.1	9.9	0.003	1.1	c	1.1	0.00071	0.0142	0.003	Leachability SCTL
3-NITROANILINE	99-09-2	21	130	0.01	NC	NC	NC	NC	NC	0.01	Leachability SCTL
4,6-DINITRO-2-METHYLPHENOL	534-52-1	8.4	180	0.4	4.9	n	0.49	0.002	0.04	0.04	Leachability SCTL
4-BROMOPHENYL-PHENYLETHER	101-55-3	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
4-CHLORO-3-METHYLPHENOL	59-50-7	600	8000	0.4	6100	n	610	1.3	26	0.4	Leachability SCTL
4-CHLOROANILINE	106-47-8	270	3700	0.2	2.4	c	2.4	0.00013	0.0026	0.0026	EPA Migration to GW
4-CHLOROPHENYL-PHENYL ETHER	7005-72-3	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
4-METHYLPHENOL	106-44-5	300	3400	0.03	310	n	31	0.057	1.14	0.03	Leachability SCTL
4-NITROANILINE	100-01-6	17	96	0.008	24	c*	24	0.0014	0.028	0.008	Leachability SCTL
4-NITROPHENOL	100-02-7	560	7900	0.3	NC	NC	NC	NC	NC	0.3	Leachability SCTL
ACENAPHTHENE	83-32-9	2400	20000	2.1	3400	n	340	4.1	82	2.1	Leachability SCTL
ACENAPHTHYLENE	208-96-8	1800	20000	27	3400	n	340	4.1	82	27	Leachability SCTL
ANTHRACENE	120-12-7	21000	300000	2500	17000	n	1700	42	840	840	EPA Migration to GW
ATRAZINE	1912-24-9	4.3	19	0.06	2.1	c	2.1	0.00017	0.0034	0.0034	EPA Migration to GW
BENZALDEHYDE	100-52-7	3300	24000	4.8	7800	n	780	0.33	6.6	4.8	Leachability SCTL
BENZO (A) ANTHRACENE	56-55-3	NC	NC	0.8	0.15	c	0.15	0.01	0.2	0.15	EPA RSL
BENZO (A) PYRENE	50-32-8	0.1	0.7	8	0.015	c	0.015	0.0035	0.07	0.015	EPA RSL
BENZO (B) FLUOROANTHENE	205-99-2	NC	NC	2.4	0.15	c	0.15	0.035	0.7	0.15	EPA RSL
BENZO (G,H,I) PERYLENE	191-24-2	2500	52000	32000	1700	n	170	9.5	190	170	EPA RSL
BENZO (K) FLUOROANTHENE	207-08-9	NC	NC	24	1.5	c	1.5	0.35	7	1.5	EPA RSL
BIS(2-CHLOROETHOXY) METHANE	111-91-1	250	5700	63	180	n	18	0.011	0.22	0.22	EPA Migration to GW
BIS-(2-CHLOROETHYL) ETHER	111-44-4	0.3	0.5	0.0001	0.21	c	0.21	0.0000031	0.000062	0.000062	EPA Migration to GW
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7	72	390	3600	35	c*	35	0.017	0.34	0.34	EPA Migration to GW
BUTYLBENZYLPHTHALATE	85-68-7	17000	380000	310	260	c*	260	0.2	4	4	EPA Migration to GW
CAPROLACTAM	105-60-2	NC	NC	NC	31000	n	3100	1.9	38	38	EPA Migration to GW
CARBAZOLE	86-74-8	49	240	0.2	NC	NC	NC	NC	NC	0.2	Leachability SCTL
CHRYSENE	218-01-9	NC	NC	77	15	c	15	1.1	22	15	EPA RSL
DIBENZO (A,H)-ANTHRACENE	53-70-3	NC	NC	0.7	0.015	c	0.015	0.011	0.22	0.015	EPA RSL
DIBENZOFURAN	132-64-9	320	63000	15	78	n	7.8	0.11	2.2	2.2	EPA Migration to GW
DIETHYLPHTHALATE	84-66-2	61000	NC	86	49000	n	4900	4.7	94	86	Leachability SCTL
DIMETHYLPHTHALATE	131-11-3	690000	NC	380	NC	NC	NC	NC	NC	380	Leachability SCTL
DI-N-BUTYLPHTHALATE	84-74-2	8200	170000	47	6100	n	610	1.7	34	34	EPA Migration to GW
DI-N-OCTYLPHTHALATE	117-84-0	1700	39000	480000	NC	NC	NC	NC	NC	1700	Res SCTL
FLUORANTHENE	206-44-0	3200	59000	1200	2300	n	230	70	1400	230	EPA RSL
FLUORENE	86-73-7	2600	33000	160	2300	n	230	4	80	80	EPA Migration to GW
HEXACHLOROBENZENE	118-74-1	0.4	1.2	2.2	0.3	c	0.3	0.00053	0.0106	0.0106	EPA Migration to GW
HEXACHLOROBUTADIENE	87-68-3	6.2	13	1	6.2	c**	6.2	0.0005	0.01	0.01	EPA Migration to GW
HEXACHLOROCYCLOPENTADIENE	77-47-4	9.5	50	400	370	n	37	0.07	1.4	1.4	EPA Migration to GW
HEXACHLOROETHANE	67-72-1	38	87	0.2	12	c**	12	0.00048	0.0096	0.0096	EPA Migration to GW
INDENO (1,2,3-CD)-PYRENE	193-39-5	NC	NC	6.6	0.15	c	0.15	0.12	2.4	0.15	EPA RSL
ISOPHORONE	78-59-1	540	1200	0.2	510	c*	510	0.022	0.44	0.2	Leachability SCTL
NAPHTHALENE	91-20-3	55	300	1.2	3.6	c*	3.6	0.00047	0.0094	0.0094	EPA Migration to GW
NITROBENZENE	98-95-3	18	140	0.02	4.8	c*	4.8	0.000079	0.00158	0.00158	EPA Migration to GW
N-NITROSO DIPHENYLAMINE	86-30-6	180	730	0.4	99	c	99	0.057	1.14	0.4	Leachability SCTL
N-NITROSO-DI-N PROPYLAMINE	621-64-7	0.08	0.2	0.00005	0.069	c	0.069	0.000007	0.00014	0.00005	Leachability SCTL
PENTACHLOROPHENOL	87-86-5	7.2	28	0.03	0.89	c	0.89	0.0017	0.034	0.03	Leachability SCTL
PHENANTHRENE	85-01-8	2200	36000	250	1700	n	170	9.5	190	170	EPA RSL
PHENOL	108-95-2	500	220000	0.05	18000	n	1800	2.6	52	0.05	Leachability SCTL

Chemical	CAS No.	Residential SCTL (mg/kg)	Industrial SCTL (mg/kg)	Leachability Based on Groundwater (mg/kg)	EPA Residential Soil Direct Contact (mg/kg)	Basis	Adjusted EPA Residential Soil Direct Contact (mg/kg)	EPA Migration to GW DAF 1 (mg/kg)	EPA Migration to GW DAF 20 (mg/kg)	PAL (mg/kg) Minimum	PAL Reference
PYRENE	129-00-0	2400	45000	880	1700	n	170	9.5	190	170	EPA RSL
TCL Pesticides											
4,4'-DDD	72-54-8	4.2	22	5.8	2	c	2	0.066	1.32	1.32	EPA Migration to GW
4,4'-DDE	72-55-9	2.9	15	18	1.4	c	1.4	0.046	0.92	0.92	EPA Migration to GW
4,4'-DDT	50-29-3	2.9	15	11	1.7	c*	1.7	0.067	1.34	1.34	EPA Migration to GW
ALDRIN	309-00-2	0.06	0.3	0.2	0.029	c*	0.029	0.000034	0.00068	0.00068	EPA Migration to GW
ALPHA-BHC	319-84-6	0.1	0.6	0.0003	0.077	c	0.077	0.000036	0.00072	0.0003	Leachability SCTL
ALPHA-CHLORDANE	5103-71-9	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
BETA-BHC	319-85-7	0.5	2.4	0.001	0.27	c	0.27	0.00013	0.0026	0.001	Leachability SCTL
DELTA-BHC	319-86-8	24	490	0.2	NC	NC	NC	NC	NC	0.2	Leachability SCTL
DIELDRIN	60-57-1	0.06	0.3	0.002	0.03	c	0.03	0.000061	0.00122	0.00122	EPA Migration to GW
ENDOSULFAN I	959-98-8	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
ENDOSULFAN II	33213-65-9	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
ENDOSULFAN SULFATE	1031-07-8	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
ENDRIN	72-20-8	25	510	1	18	n	1.8	0.068	1.36	1	Leachability SCTL
ENDRIN ALDEHYDE	7421-93-4	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
ENDRIN KETONE	53494-70-5	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
GAMMA-BHC (LINDANE)	58-89-9	0.7	2.5	0.009	0.52	c*	0.52	0.00021	0.0042	0.0042	EPA Migration to GW
GAMMA-CHLORDANE	5103-74-2	NC	NC	NC	NC	NC	NC	NC	NC	NC	None
HEPTACHLOR	76-44-8	0.2	1	23	0.11	c	0.11	0.00014	0.0028	0.0028	EPA Migration to GW
HEPTACHLOR EPOXIDE	1024-57-3	0.1	0.5	0.6	0.053	c*	0.053	0.000068	0.00136	0.00136	EPA Migration to GW
METHOXYCHLOR	72-43-5	420	8800	160	310	n	31	1.5	30	30	EPA Migration to GW
TOXAPHENE	8001-35-2	0.9	4.5	31	0.44	c	0.44	0.0021	0.042	0.042	EPA Migration to GW
TCL PCBs											
AROCLOR-1016	12674-11-2	NC	NC	NC	3.9	n	0.39	0.092	1.84	0.39	EPA RSL
AROCLOR-1221	11104-28-2	NC	NC	NC	0.14	c	0.14	0.000074	0.00148	0.00148	EPA Migration to GW
AROCLOR-1232	11141-16-5	NC	NC	NC	0.14	c	0.14	0.000074	0.00148	0.00148	EPA Migration to GW
AROCLOR-1242	53469-21-9	NC	NC	NC	0.22	c	0.22	0.0053	0.106	0.106	EPA Migration to GW
AROCLOR-1248	12672-29-6	NC	NC	NC	0.22	c	0.22	0.0052	0.104	0.104	EPA Migration to GW
AROCLOR-1254	11097-69-1	NC	NC	NC	0.22	c**	0.22	0.0088	0.176	0.11	EPA RSL
AROCLOR-1260	11096-82-5	NC	NC	NC	0.22	c	0.22	0.024	0.48	0.22	EPA RSL
TOTAL AROCLOR	1336-36-3	0.5	2.6	17	NC	c	NC	NC	NC	0.5	Res SCTL

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
ALAR	1596-84-5	2.7E+01	c	9.6E+01	c	4.8E-01	c	2.4E+00	c	3.7E+00	c		8.2E-04	
Acephate	30560-19-1	5.6E+01	c**	2.0E+02	c*					7.7E+00	c**		1.7E-03	
Acetaldehyde	75-07-0	1.0E+01	c**	5.2E+01	c**	1.1E+00	c**	5.6E+00	c**	2.2E+00	c**		4.5E-04	
Acetochlor	34256-82-1	1.2E+03	n	1.2E+04	n					2.7E+02	n		2.2E-01	
Acetone	67-64-1	6.1E+04	n	6.3E+05	nms	3.2E+04	n	1.4E+05	n	1.2E+04	n		2.4E+00	
Acetone Cyanohydrin	75-86-5	2.0E+02	n	2.1E+03	n	6.3E+01	n	2.6E+02	n	3.4E+01	n		6.9E-03	
Acetonitrile	75-05-8	8.7E+02	n	3.7E+03	n	6.3E+01	n	2.6E+02	n	1.3E+02	n		2.6E-02	
Acetophenone	98-86-2	7.8E+03	ns	1.0E+05	nms					1.5E+03	n		4.5E-01	
Acetylaminofluorene, 2-	53-96-3	1.3E-01	c	4.5E-01	c	1.9E-03	c	9.4E-03	c	1.4E-02	c		6.5E-05	
Acrolein	107-02-8	1.5E-01	n	6.5E-01	n	2.1E-02	n	8.8E-02	n	4.1E-02	n		8.4E-06	
Acrylamide	79-06-1	2.3E-01	c	3.4E+00	c	9.6E-03	c	1.2E-01	c	4.3E-02	c		9.1E-06	
Acrylic Acid	79-10-7	3.0E+04	n	2.9E+05	nm	1.0E+00	n	4.4E+00	n	7.7E+03	n		1.6E+00	
Acrylonitrile	107-13-1	2.4E-01	c*	1.2E+00	c*	3.6E-02	c*	1.8E-01	c*	4.5E-02	c*		9.8E-06	
Adiponitrile	111-69-3	8.5E+06	nm	3.6E+07	nm	6.3E+00	n	2.6E+01	n					
Alachlor	15972-60-8	8.7E+00	c*	3.1E+01	c					9.1E-01	c	2.0E+00	7.5E-04	1.6E-03
Aldicarb	116-06-3	6.1E+01	n	6.2E+02	n					1.5E+01	n		3.8E-03	
Aldicarb Sulfone	1646-88-4	6.1E+01	n	6.2E+02	n					1.6E+01	n		3.4E-03	
Aldrin	309-00-2	2.9E-02	c*	1.0E-01	c	5.0E-04	c	2.5E-03	c	2.1E-04	c		3.4E-05	
Ally	74223-64-6	1.5E+04	n	1.5E+05	nm					3.8E+03	n		1.5E+00	
Allyl Alcohol	107-18-6	3.0E+02	n	3.1E+03	n	1.0E-01	n	4.4E-01	n	7.8E+01	n		1.6E-02	
Allyl Chloride	107-05-1	6.8E-01	c**	3.4E+00	c**	4.1E-01	c**	2.0E+00	c**	6.3E-01	c**		2.0E-04	
Aluminum	7429-90-5	7.7E+04	n	9.9E+05	nm	5.2E+00	n	2.2E+01	n	1.6E+04	n		2.3E+04	
Aluminum Phosphide	20859-73-8	3.1E+01	n	4.1E+02	n					6.2E+00	n			
Amdro	67485-29-4	1.8E+01	n	1.8E+02	n					4.7E+00	n		1.7E+03	
Ametryn	834-12-8	5.5E+02	n	5.5E+03	n					1.2E+02	n		1.2E-01	
Aminobiphenyl, 4-	92-67-1	2.3E-02	c	8.2E-02	c	4.1E-04	c	2.0E-03	c	2.6E-03	c		1.3E-05	
Aminophenol, m-	591-27-5	4.9E+03	n	4.9E+04	n					1.2E+03	n		4.7E-01	
Aminophenol, p-	123-30-8	1.2E+03	n	1.2E+04	n					3.1E+02	n		1.2E-01	
Amitraz	33089-61-1	1.5E+02	n	1.5E+03	n					5.9E+00	n		3.0E+00	
Ammonia	7664-41-7					1.0E+02	n	4.4E+02	n					
Ammonium Sulfamate	7773-06-0	1.6E+04	n	2.0E+05	nm					3.1E+03	n			
Aniline	62-53-3	8.5E+01	c**	3.0E+02	c*	1.0E+00	n	4.4E+00	n	1.2E+01	c**		3.9E-03	
Anthraquinone, 9,10-	84-65-1	1.2E+01	c*	4.3E+01	c*					1.2E+00	c*		1.2E-02	
Antimony (metallic)	7440-36-0	3.1E+01	n	4.1E+02	n					6.0E+00	n	6.0E+00	2.7E-01	2.7E-01
Antimony Pentoxide	1314-60-9	3.9E+01	n	5.1E+02	n					7.5E+00	n			
Antimony Potassium Tartrate	11071-15-1	7.0E+01	n	9.2E+02	n					1.3E+01	n			
Antimony Tetroxide	1332-81-6	3.1E+01	n	4.1E+02	n					6.0E+00	n			
Antimony Trioxide	1309-64-4	2.8E+05	nm	1.2E+06	nm	2.1E-01	n	8.8E-01	n					
Apollo	74115-24-5	7.9E+02	n	8.0E+03	n					1.8E+02	n		1.1E+01	
Aramite	140-57-8	1.9E+01	c	6.9E+01	c	3.4E-01	c	1.7E+00	c	2.7E+00	c		3.0E-02	
Arsenic, Inorganic	7440-38-2	3.9E-01	c*	1.6E+00	c	5.7E-04	c*	2.9E-03	c*	4.5E-02	c	1.0E+01	1.3E-03	2.9E-01
Arsine	7784-42-1	2.7E-01	n	3.6E+00	n	5.2E-02	n	2.2E-01	n	5.4E-02	n			
Assure	76578-14-8	5.5E+02	n	5.5E+03	n					9.3E+01	n		1.4E+00	
Asulam	3337-71-1	3.1E+03	n	3.1E+04	n					7.8E+02	n		2.0E-01	
Atrazine	1912-24-9	2.1E+00	c	7.5E+00	c					2.6E-01	c	3.0E+00	1.7E-04	1.9E-03
Auramine	492-80-8	5.5E-01	c	2.0E+00	c	9.7E-03	c	4.9E-02	c	6.7E-02	c		6.1E-04	
Avermectin B1	65195-55-3	2.4E+01	n	2.5E+02	n					6.3E+00	n		1.1E+01	
Azobenzene	103-33-3	5.1E+00	c	2.3E+01	c	7.8E-02	c	4.0E-01	c	1.0E-01	c		8.0E-04	
Barium	7440-39-3	1.5E+04	n	1.9E+05	nm	5.2E-01	n	2.2E+00	n	2.9E+03	n	2.0E+03	1.2E+02	8.2E+01
Baygon	114-26-1	2.4E+02	n	2.5E+03	n					6.1E+01	n		2.0E-02	
Bayleton	43121-43-3	1.8E+03	n	1.8E+04	n					4.3E+02	n		3.4E-01	
Baythroid	68359-37-5	1.5E+03	n	1.5E+04	n					8.7E+01	n		2.3E+01	
Benefin	1861-40-1	1.8E+04	n	1.8E+05	nm					1.2E+03	n		4.1E+01	
Benomyl	17804-35-2	3.1E+03	n	3.1E+04	n					7.5E+02	n		6.6E-01	
Bentazon	25057-89-0	1.8E+03	n	1.8E+04	n					4.4E+02	n		9.6E-02	
Benzaldehyde	100-52-7	7.8E+03	ns	1.0E+05	nms					1.5E+03	n		3.3E-01	
Benzene	71-43-2	1.1E+00	c*	5.4E+00	c*	3.1E-01	c	1.6E+00	c*	3.9E-01	c*	5.0E+00	2.0E-04	2.6E-03
Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	1.2E+01	n	1.2E+02	n					3.1E+00	n			

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
Benzenethiol	108-98-5	7.8E+01	n	1.0E+03	n					1.3E+01	n		8.6E-03	
Benzidine	92-87-5	5.0E-04	c	7.5E-03	c	1.4E-05	c	1.8E-04	c	9.2E-05	c		2.4E-07	
Benzoic Acid	65-85-0	2.4E+05	nm	2.5E+06	nm					5.8E+04	n		1.4E+01	
Benzotrichloride	98-07-7	4.9E-02	c	2.2E-01	c					2.6E-03	c		5.6E-06	
Benzyl Alcohol	100-51-6	6.1E+03	n	6.2E+04	n					1.5E+03	n		3.7E-01	
Benzyl Chloride	100-44-7	1.0E+00	c*	4.9E+00	c*	5.0E-02	c*	2.5E-01	c*	7.7E-02	c*		8.4E-05	
Beryllium and compounds	7440-41-7	1.6E+02	n	2.0E+03	n	1.0E-03	c*	5.1E-03	c*	1.6E+01	n	4.0E+00	1.3E+01	3.2E+00
Bidrin	141-66-2	6.1E+00	n	6.2E+01	n					1.6E+00	n		3.6E-04	
Bifenox	42576-02-3	5.5E+02	n	5.5E+03	n					7.5E+01	n		5.7E-01	
Biphenthrin	82657-04-3	9.2E+02	n	9.2E+03	n					2.3E+02	n		1.1E+03	
Biphenyl, 1,1'-	92-52-4	5.1E+01	n	2.1E+02	n	4.2E-01	n	1.8E+00	n	8.3E-01	n		8.7E-03	
Bis(2-chloro-1-methylethyl) ether	108-60-1	4.6E+00	c	2.2E+01	c	2.4E-01	c	1.2E+00	c	3.1E-01	c		1.1E-04	
Bis(2-chloroethoxy)methane	111-91-1	1.8E+02	n	1.8E+03	n					4.7E+01	n		1.1E-02	
Bis(2-chloroethyl)ether	111-44-4	2.1E-01	c	1.0E+00	c	7.4E-03	c	3.7E-02	c	1.2E-02	c		3.1E-06	
Bis(2-ethylhexyl)phthalate	117-81-7	3.5E+01	c*	1.2E+02	c	1.0E+00	c	5.1E+00	c	7.1E-02	c*	6.0E+00	1.7E-02	1.4E+00
Bis(chloromethyl)ether	542-88-1	7.7E-05	c	3.9E-04	c	3.9E-05	c	2.0E-04	c	6.2E-05	c		1.5E-08	
Bisphenol A	80-05-7	3.1E+03	n	3.1E+04	n					5.8E+02	n		4.4E+01	
Boron And Borates Only	7440-42-8	1.6E+04	n	2.0E+05	nm	2.1E+01	n	8.8E+01	n	3.1E+03	n		9.9E+00	
Boron Trifluoride	7637-07-2	3.1E+03	n	4.1E+04	n	1.4E+01	n	5.7E+01	n	6.2E+02	n			
Bromate	15541-45-4	9.1E-01	c	4.1E+00	c					9.6E-02	c	1.0E+01	7.4E-04	7.7E-02
Bromo-2-chloroethane, 1-	107-04-0	2.4E-02	c	1.2E-01	c	4.1E-03	c	2.0E-02	c	6.5E-03	c		1.8E-06	
Bromobenzene	108-86-1	3.0E+02	n	1.8E+03	ns	6.3E+01	n	2.6E+02	n	5.4E+01	n		3.6E-02	
Bromochloromethane	74-97-5	1.6E+02	n	6.8E+02	n	4.2E+01	n	1.8E+02	n	8.3E+01	n		2.1E-02	
Bromodichloromethane	75-27-4	2.7E-01	c	1.4E+00	c	6.6E-02	c	3.3E-01	c	1.2E-01	c	8.0E+01(F	3.2E-05	2.2E-02
Bromoform	75-25-2	6.2E+01	c*	2.2E+02	c*	2.2E+00	c	1.1E+01	c	7.9E+00	c*	8.0E+01(F	2.1E-03	2.1E-02
Bromomethane	74-83-9	7.3E+00	n	3.2E+01	n	5.2E+00	n	2.2E+01	n	7.0E+00	n		1.8E-03	
Bromophos	2104-96-3	3.1E+02	n	3.1E+03	n					2.6E+01	n		1.1E-01	
Bromoxynil	1689-84-5	1.2E+03	n	1.2E+04	n					3.1E+02	n		2.7E-01	
Bromoxynil Octanoate	1689-99-2	1.2E+03	n	1.2E+04	n					1.0E+02	n		8.7E-01	
Butadiene, 1,3-	106-99-0	5.4E-02	c*	2.6E-01	c*	8.1E-02	c*	4.1E-01	c*	1.6E-02	c		8.6E-06	
Butanol, N-	71-36-3	6.1E+03	n	6.2E+04	n					1.5E+03	n		3.2E-01	
Butyl Benzyl Phthlate	85-68-7	2.6E+02	c*	9.1E+02	c					1.4E+01	c*		2.0E-01	
Butyl alcohol, sec-	78-92-2	1.2E+05	nm	1.2E+06	nm	3.1E+04	n	1.3E+05	n	3.1E+04	n		6.3E+00	
Butylate	2008-41-5	3.1E+03	n	3.1E+04	n					3.4E+02	n		3.3E-01	
Butylated hydroxyanisole	25013-16-5	2.4E+03	c	8.6E+03	c	4.3E+01	c	2.2E+02	c	3.4E+02	c		6.3E-01	
Butylbenzene, n-	104-51-8	3.9E+03	ns	5.1E+04	ns					7.8E+02	n		2.5E+00	
Butylphthalyl Butylglycolate	85-70-1	6.1E+04	n	6.2E+05	nm					1.6E+04	n		3.5E+02	
Cacodylic Acid	75-60-5	1.2E+03	n	1.2E+04	n					3.1E+02	n			
Cadmium (Diet)	7440-43-9	7.0E+01	n	8.0E+02	n									
Cadmium (Water)	7440-43-9					1.4E-03	c*	6.8E-03	c*	6.9E+00	n	5.0E+00	5.2E-01	3.8E-01
Caprolactam	105-60-2	3.1E+04	n	3.1E+05	nm					7.7E+03	n		1.9E+00	
Captafol	2425-06-1	3.2E+00	c*	1.1E+01	c	5.7E-02	c	2.9E-01	c	3.5E-01	c*		6.1E-04	
Captan	133-06-2	2.1E+02	c*	7.5E+02	c	3.7E+00	c	1.9E+01	c	2.7E+01	c*		1.9E-02	
Carbaryl	63-25-2	6.1E+03	n	6.2E+04	n					1.4E+03	n		1.3E+00	
Carbofuran	1563-66-2	3.1E+02	n	3.1E+03	n					7.3E+01	n	4.0E+01	2.8E-02	1.6E-02
Carbon Disulfide	75-15-0	8.2E+02	ns	3.7E+03	ns	7.3E+02	n	3.1E+03	n	7.2E+02	n		2.1E-01	
Carbon Tetrachloride	56-23-5	6.1E-01	c	3.0E+00	c	4.1E-01	c	2.0E+00	c	3.9E-01	c	5.0E+00	1.5E-04	1.9E-03
Carbosulfan	55285-14-8	6.1E+02	n	6.2E+03	n					1.6E+02	n		3.8E+00	
Carboxin	5234-68-4	6.1E+03	n	6.2E+04	n					1.5E+03	n		8.0E-01	
Ceric oxide	1306-38-3	1.3E+06	nm	5.4E+06	nm	9.4E-01	n	3.9E+00	n					
Chloral Hydrate	302-17-0	6.1E+03	n	6.2E+04	n					1.5E+03	n		3.1E-01	
Chloramben	133-90-4	9.2E+02	n	9.2E+03	n					2.3E+02	n		5.7E-02	
Chloranil	118-75-2	1.2E+00	c	4.3E+00	c					1.7E-01	c		1.4E-04	
Chlordane	12789-03-6	1.6E+00	c*	6.5E+00	c*	2.4E-02	c*	1.2E-01	c*	1.9E-01	c*	2.0E+00	1.3E-02	1.4E-01
Chlordecone (Kepone)	143-50-0	4.9E-02	c	1.7E-01	c	5.3E-04	c	2.7E-03	c	3.0E-03	c		1.1E-04	
Chlorfenvinphos	470-90-6	4.3E+01	n	4.3E+02	n					8.6E+00	n		2.3E-02	
Chlorimuron, Ethyl-	90982-32-4	1.2E+03	n	1.2E+04	n					3.0E+02	n		1.0E-01	
Chlorine	7782-50-5	7.5E+03	n	9.1E+04	n	1.5E-01	n	6.4E-01	n	1.6E+03	n		7.0E-01	

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
Chlorine Dioxide	10049-04-4	2.3E+03	n	3.0E+04	n	2.1E-01	n	8.8E-01	n	4.7E+02	n			
Chlorite (Sodium Salt)	7758-19-2	2.3E+03	n	3.1E+04	n					4.7E+02	n	1.0E+03		
Chloro-1,1-difluoroethane, 1-	75-68-3	5.8E+04	ns	2.4E+05	nms	5.2E+04	n	2.2E+05	n	1.0E+05	n		5.2E+01	
Chloro-1,3-butadiene, 2-	126-99-8	9.4E-03	c	4.7E-02	c	8.1E-03	c	4.1E-02	c	1.6E-02	c		8.5E-06	
Chloro-2-methylaniline HCl, 4-	3165-93-3	1.1E+00	c	3.7E+00	c					1.3E-01	c		7.4E-05	
Chloro-2-methylaniline, 4-	95-69-2	4.9E+00	c*	1.7E+01	c	3.2E-02	c	1.6E-01	c	6.7E-01	c*		3.8E-04	
Chloroacetaldehyde, 2-	107-20-0	1.8E+00	c	6.4E+00	c					2.5E-01	c		5.0E-05	
Chloroacetic Acid	79-11-8	1.2E+02	n	1.2E+03	n					3.1E+01	n	6.0E+01	6.3E-03	1.2E-02
Chloroacetophenone, 2-	532-27-4	4.3E+04	n	1.8E+05	nm	3.1E-02	n	1.3E-01	n					
Chloroaniline, p-	106-47-8	2.4E+00	c	8.6E+00	c					3.2E-01	c		1.3E-04	
Chlorobenzene	108-90-7	2.9E+02	n	1.4E+03	ns	5.2E+01	n	2.2E+02	n	7.2E+01	n	1.0E+02	4.9E-02	6.8E-02
Chlorobenzilate	510-15-6	4.4E+00	c	1.6E+01	c	7.8E-02	c	4.0E-01	c	2.7E-01	c		8.8E-04	
Chlorobenzoic Acid, p-	74-11-3	1.8E+03	n	1.8E+04	n					3.9E+02	n		9.9E-02	
Chlorobenzotrifluoride, 4-	98-56-6	2.1E+02	ns	2.3E+03	ns	3.1E+02	n	1.3E+03	n	2.6E+01	n		9.3E-02	
Chlorobutane, 1-	109-69-3	3.1E+03	ns	4.1E+04	ns					4.8E+02	n		2.0E-01	
Chlorodifluoromethane	75-45-6	5.3E+04	ns	2.2E+05	nms	5.2E+04	n	2.2E+05	n	1.0E+05	n		4.3E+01	
Chloroform	67-66-3	2.9E-01	c	1.5E+00	c	1.1E-01	c	5.3E-01	c	1.9E-01	c	8.0E+01(F	5.3E-05	2.2E-02
Chloromethane	74-87-3	1.2E+02	n	5.0E+02	n	9.4E+01	n	3.9E+02	n	1.9E+02	n		4.9E-02	
Chloromethyl Methyl Ether	107-30-2	1.9E-02	c	9.4E-02	c	3.5E-03	c	1.8E-02	c	5.6E-03	c		1.2E-06	
Chloronaphthalene, Beta-	91-58-7	6.3E+03	ns	8.2E+04	ns					5.5E+02	n		2.9E+00	
Chloronitrobenzene, o-	88-73-3	1.6E+00	c	5.7E+00	c	1.0E-02	n	4.4E-02	n	2.0E-01	c		1.9E-04	
Chloronitrobenzene, p-	100-00-5	6.1E+01	n	2.7E+02	c**	6.3E-01	n	2.6E+00	n	9.4E+00	c**		8.7E-03	
Chlorophenol, 2-	95-57-8	3.9E+02	n	5.1E+03	n					7.1E+01	n		5.7E-02	
Chloropicrin	76-06-2	2.1E+00	n	8.8E+00	n	4.2E-01	n	1.8E+00	n	8.3E-01	n		2.5E-04	
Chlorothalonil	1897-45-6	1.6E+02	c**	5.6E+02	c*	2.7E+00	c	1.4E+01	c	1.9E+01	c*		4.3E-02	
Chlorotoluene, o-	95-49-8	1.6E+03	ns	2.0E+04	ns					1.8E+02	n		1.7E-01	
Chlorotoluene, p-	106-43-4	1.6E+03	ns	2.0E+04	ns					1.9E+02	n		1.8E-01	
Chlorozotocin	54749-90-5	2.0E-03	c	7.2E-03	c	3.5E-05	c	1.8E-04	c	2.8E-04	c		6.2E-08	
Chlorpropham	101-21-3	1.2E+04	n	1.2E+05	nm					2.2E+03	n		1.9E+00	
Chlorpyrifos	2921-88-2	6.1E+01	n	6.2E+02	n					6.2E+00	n		9.2E-02	
Chlorpyrifos Methyl	5598-13-0	6.1E+02	n	6.2E+03	n					8.9E+01	n		4.1E-01	
Chlorsulfuron	64902-72-3	3.1E+03	n	3.1E+04	n					7.7E+02	n		6.5E-01	
Chlorthiophos	60238-56-4	4.9E+01	n	4.9E+02	n					2.0E+00	n		5.2E-02	
Chromium(III), Insoluble Salts	16065-83-1	1.2E+05	nm	1.5E+06	nm					1.6E+04	n		2.8E+07	
Chromium(VI)	18540-29-9	2.9E-01	c	5.6E+00	c	1.1E-05	c	1.5E-04	c	3.1E-02	c		5.9E-04	
Chromium, Total	7440-47-3											1.0E+02		1.8E+05
Cobalt	7440-48-4	2.3E+01	n	3.0E+02	n	2.7E-04	c*	1.4E-03	c*	4.7E+00	n		2.1E-01	
Coke Oven Emissions	8007-45-2					1.5E-03	c	2.0E-02	c					
Copper	7440-50-8	3.1E+03	n	4.1E+04	n					6.2E+02	n	1.3E+03	2.2E+01	4.6E+01
Cresol, m-	108-39-4	3.1E+03	n	3.1E+04	n	6.3E+02	n	2.6E+03	n	7.2E+02	n		5.7E-01	
Cresol, o-	95-48-7	3.1E+03	n	3.1E+04	n	6.3E+02	n	2.6E+03	n	7.2E+02	n		5.8E-01	
Cresol, p-	106-44-5	3.1E+02	n	3.1E+03	n	6.3E+02	n	2.6E+03	n	7.2E+01	n		5.7E-02	
Cresol, p-chloro-m-	59-50-7	6.1E+03	n	6.2E+04	n					1.1E+03	n		1.3E+00	
Cresols	1319-77-3	7.5E+03	n	9.1E+04	ns	6.3E+02	n	2.6E+03	n	6.7E+02	n		5.4E-01	
Crotonaldehyde, trans-	123-73-9	3.4E-01	c	1.5E+00	c					3.5E-02	c		7.1E-06	
Cumene	98-82-8	2.1E+03	ns	1.1E+04	ns	4.2E+02	n	1.8E+03	n	3.9E+02	n		6.4E-01	
Cupferron	135-20-6	2.2E+00	c	7.8E+00	c	3.9E-02	c	1.9E-01	c	3.1E-01	c		5.3E-04	
Cyanazine	21725-46-2	5.8E-01	c	2.1E+00	c					7.6E-02	c		3.5E-05	
Cyanides														
~Calcium Cyanide	592-01-8	3.1E+03	n	4.1E+04	n					6.2E+02	n			
~Copper Cyanide	544-92-3	3.9E+02	n	5.1E+03	n					7.8E+01	n			
~Cyanide (CN-)	57-12-5	1.6E+03	n	2.0E+04	n					3.1E+02	n	2.0E+02	3.1E+00	2.0E+00
~Cyanogen	460-19-5	3.1E+03	n	4.1E+04	n					6.2E+02	n			
~Cyanogen Bromide	506-68-3	7.0E+03	n	9.2E+04	n					1.4E+03	n			
~Cyanogen Chloride	506-77-4	3.9E+03	n	5.1E+04	n					7.8E+02	n			
~Hydrogen Cyanide	74-90-8	4.7E+01	n	6.1E+02	n	8.3E-01	n	3.5E+00	n	1.4E+00	n			
~Potassium Cyanide	151-50-8	3.9E+03	n	5.1E+04	n					7.7E+02	n			
~Potassium Silver Cyanide	506-61-6	1.6E+04	n	2.0E+05	nm					2.4E+03	n			

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
~Silver Cyanide	506-64-9	7.8E+03	n	1.0E+05	nm					1.3E+03	n			
~Sodium Cyanide	143-33-9	3.1E+03	n	4.1E+04	n					6.2E+02	n	2.0E+02		
~Thiocyanate	463-56-9	1.6E+01	n	2.0E+02	n					3.1E+00	n		6.6E-04	
~Zinc Cyanide	557-21-1	3.9E+03	n	5.1E+04	n					7.8E+02	n			
Cyclohexane	110-82-7	7.0E+03	ns	2.9E+04	ns	6.3E+03	n	2.6E+04	n	1.3E+04	n		1.3E+01	
Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.1E+01	c	7.5E+01	c					2.1E+00	c		1.2E-02	
Cyclohexanone	108-94-1	3.1E+05	nm	3.1E+06	nm	7.3E+02	n	3.1E+03	n	7.7E+04	n		1.8E+01	
Cyclohexylamine	108-91-8	1.2E+04	n	1.2E+05	nm					3.0E+03	n		7.9E-01	
Cyhalothrin/karate	68085-85-8	3.1E+02	n	3.1E+03	n					7.8E+01	n		5.3E+01	
Cypermethrin	52315-07-8	6.1E+02	n	6.2E+03	n					1.6E+02	n		2.5E+01	
Cyromazine	66215-27-8	4.6E+02	n	4.6E+03	n					1.2E+02	n		3.0E-02	
DDD	72-54-8	2.0E+00	c	7.2E+00	c	3.5E-02	c	1.8E-01	c	2.8E-01	c		6.6E-02	
DDE, p,p'-	72-55-9	1.4E+00	c	5.1E+00	c	2.5E-02	c	1.3E-01	c	2.0E-01	c		4.6E-02	
DDT	50-29-3	1.7E+00	c*	7.0E+00	c*	2.5E-02	c	1.3E-01	c	2.0E-01	c*		6.7E-02	
Dacthal	1861-32-1	6.1E+02	n	6.2E+03	n					9.3E+01	n		1.1E-01	
Dalapon	75-99-0	1.8E+03	n	1.8E+04	n					4.7E+02	n	2.0E+02	9.7E-02	4.1E-02
Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	4.3E+02	n	2.5E+03	c**					9.6E+01	c**		5.3E+01	
Demeton	8065-48-3	2.4E+00	n	2.5E+01	n					5.2E-01	n			
Di(2-ethylhexyl)adipate	103-23-1	4.1E+02	c*	1.4E+03	c					5.6E+01	c	4.0E+02	4.0E+00	2.9E+01
Diallate	2303-16-4	8.0E+00	c	2.8E+01	c					4.6E-01	c		6.8E-04	
Diazinon	333-41-5	4.3E+01	n	4.3E+02	n					7.9E+00	n		4.9E-02	
Dibromo-3-chloropropane, 1,2-	96-12-8	5.4E-03	c	6.9E-02	c	1.6E-04	c	2.0E-03	c	3.2E-04	c	2.0E-01	1.4E-07	8.6E-05
Dibromobenzene, 1,4-	106-37-6	6.1E+02	n	6.2E+03	n					9.8E+01	n		9.3E-02	
Dibromochloromethane	124-48-1	6.8E-01	c	3.3E+00	c	9.0E-02	c	4.5E-01	c	1.5E-01	c	8.0E+01(F	3.9E-05	2.1E-02
Dibromoethane, 1,2-	106-93-4	3.4E-02	c	1.7E-01	c	4.1E-03	c	2.0E-02	c	6.5E-03	c	5.0E-02	1.8E-06	1.4E-05
Dibromomethane (Methylene Bromide)	74-95-3	2.5E+01	n	1.1E+02	n	4.2E+00	n	1.8E+01	n	7.9E+00	n		1.9E-03	
Dibutyl Phthalate	84-74-2	6.1E+03	n	6.2E+04	n					6.7E+02	n		1.7E+00	
Dibutyltin Compounds	NA	1.8E+01	n	1.8E+02	n					4.7E+00	n			
Dicamba	1918-00-9	1.8E+03	n	1.8E+04	n					4.4E+02	n		1.1E-01	
Dichloro-2-butene, 1,4-	764-41-0	6.9E-03	c	3.5E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
Dichloro-2-butene, cis-1,4-	1476-11-5	6.9E-03	c	3.5E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
Dichloro-2-butene, trans-1,4-	110-57-6	6.9E-03	c	3.5E-02	c	5.8E-04	c	2.9E-03	c	1.2E-03	c		5.4E-07	
Dichloroacetic Acid	79-43-6	9.7E+00	c*	3.4E+01	c*					1.3E+00	c*	6.0E+01	2.7E-04	1.2E-02
Dichlorobenzene, 1,2-	95-50-1	1.9E+03	ns	9.8E+03	ns	2.1E+02	n	8.8E+02	n	2.8E+02	n	6.0E+02	2.7E-01	5.8E-01
Dichlorobenzene, 1,4-	106-46-7	2.4E+00	c	1.2E+01	c	2.2E-01	c	1.1E+00	c	4.2E-01	c	7.5E+01	4.0E-04	7.2E-02
Dichlorobenzidine, 3,3'-	91-94-1	1.1E+00	c	3.8E+00	c	7.2E-03	c	3.6E-02	c	1.1E-01	c		7.1E-04	
Dichlorobenzophenone, 4,4'-	90-98-2	5.5E+02	n	5.5E+03	n					1.4E+02	n		8.5E-01	
Dichlorodifluoromethane	75-71-8	9.4E+01	n	4.0E+02	n	1.0E+02	n	4.4E+02	n	1.9E+02	n		3.0E-01	
Dichloroethane, 1,1-	75-34-3	3.3E+00	c	1.7E+01	c	1.5E+00	c	7.7E+00	c	2.4E+00	c		6.8E-04	
Dichloroethane, 1,2-	107-06-2	4.3E-01	c*	2.2E+00	c*	9.4E-02	c*	4.7E-01	c*	1.5E-01	c*	5.0E+00	4.2E-05	1.4E-03
Dichloroethylene, 1,1-	75-35-4	2.4E+02	n	1.1E+03	n	2.1E+02	n	8.8E+02	n	2.6E+02	n	7.0E+00	9.3E-02	2.5E-03
Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	7.0E+02	n	9.2E+03	ns					1.3E+02	n		3.7E-02	
Dichloroethylene, 1,2-cis-	156-59-2	1.6E+02	n	2.0E+03	n					2.8E+01	n	7.0E+01	8.2E-03	2.1E-02
Dichloroethylene, 1,2-trans-	156-60-5	1.5E+02	n	6.9E+02	n	6.3E+01	n	2.6E+02	n	8.6E+01	n	1.0E+02	2.5E-02	2.9E-02
Dichlorophenol, 2,4-	120-83-2	1.8E+02	n	1.8E+03	n					3.5E+01	n		4.1E-02	
Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	6.9E+02	n	7.7E+03	n					1.3E+02	n	7.0E+01	3.5E-02	1.8E-02
Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6	4.9E+02	n	4.9E+03	n					9.1E+01	n		3.6E-02	
Dichloropropane, 1,2-	78-87-5	9.4E-01	c*	4.7E+00	c*	2.4E-01	c*	1.2E+00	c*	3.8E-01	c*	5.0E+00	1.3E-04	1.7E-03
Dichloropropane, 1,3-	142-28-9	1.6E+03	ns	2.0E+04	ns					2.9E+02	n		9.9E-02	
Dichloropropanol, 2,3-	616-23-9	1.8E+02	n	1.8E+03	n					4.7E+01	n		9.9E-03	
Dichloropropene, 1,3-	542-75-6	1.7E+00	c*	8.3E+00	c*	6.1E-01	c*	3.1E+00	c*	4.1E-01	c*		1.5E-04	
Dichlorvos	62-73-7	1.7E+00	c*	5.9E+00	c*	2.9E-02	c*	1.5E-01	c*	2.3E-01	c*		7.0E-05	
Dicyclopentadiene	77-73-6	3.1E+01	n	1.3E+02	ns	7.3E+00	n	3.1E+01	n	1.2E+01	n		4.3E-02	
Dieldrin	60-57-1	3.0E-02	c	1.1E-01	c	5.3E-04	c	2.7E-03	c	1.5E-03	c		6.1E-05	
Diesel Engine Exhaust	NA					8.1E-03	c	4.1E-02	c					
Diethanolamine	111-42-2	4.3E+06	nm	1.8E+07	nm	3.1E+00	n	1.3E+01	n					
Diethyl Phthalate	84-66-2	4.9E+04	n	4.9E+05	nm					1.1E+04	n		4.7E+00	
Diethylene Glycol Monobutyl Ether	112-34-5	1.8E+03	n	1.8E+04	n	1.0E-01	n	4.4E-01	n	4.7E+02	n		1.0E-01	

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
Diethylene Glycol Monoethyl Ether	111-90-0	3.6E+03	n	3.6E+04	n	3.1E-01	n	1.3E+00	n	9.4E+02	n		1.9E-01	
Diethylformamide	617-84-5	6.1E+01	n	6.2E+02	n					1.6E+01	n		3.2E-03	
Diethylstilbestrol	56-53-1	1.4E-03	c	4.9E-03	c	2.4E-05	c	1.2E-04	c	4.3E-05	c		2.4E-05	
Difenzoquat	43222-48-6	4.9E+03	n	4.9E+04	n					1.2E+03	n			
Diflubenzuron	35367-38-5	1.2E+03	n	1.2E+04	n					2.2E+02	n		2.5E-01	
Difluoroethane, 1,1-	75-37-6	5.2E+04	ns	2.2E+05	nms	4.2E+04	n	1.8E+05	n	8.3E+04	n		2.8E+01	
Dihydrosafrole	94-58-6	1.1E+01	c	3.9E+01	c	1.9E-01	c	9.4E-01	c	1.5E+00	c		1.9E-03	
Diisopropyl Ether	108-20-3	2.4E+03	ns	1.0E+04	ns	7.3E+02	n	3.1E+03	n	1.5E+03	n		3.7E-01	
Diisopropyl Methylphosphonate	1445-75-6	6.3E+03	ns	8.2E+04	ns					1.2E+03	n		3.5E-01	
Dimethipin	55290-64-7	1.2E+03	n	1.2E+04	n					3.1E+02	n		6.9E-02	
Dimethoate	60-51-5	1.2E+01	n	1.2E+02	n					3.1E+00	n		7.0E-04	
Dimethoxybenzidine, 3,3'-	119-90-4	3.5E+01	c	1.2E+02	c					4.7E+00	c		5.7E-03	
Dimethyl methylphosphonate	756-79-6	2.9E+02	c*	1.0E+03	c*					3.9E+01	c*		8.3E-03	
Dimethylamino azobenzene [p-]	60-11-7	1.1E-01	c	3.7E-01	c	1.9E-03	c	9.4E-03	c	4.3E-03	c		1.8E-05	
Dimethylaniline HCl, 2,4-	21436-96-4	8.4E-01	c	3.0E+00	c					1.1E-01	c		6.2E-05	
Dimethylaniline, 2,4-	95-68-1	2.4E+00	c*	8.6E+00	c					3.2E-01	c*		1.8E-04	
Dimethylaniline, N,N-	121-69-7	1.6E+02	n	2.0E+03	ns					2.7E+01	n		9.8E-03	
Dimethylbenzidine, 3,3'-	119-93-7	4.4E-02	c	1.6E-01	c					5.6E-03	c		3.7E-05	
Dimethylformamide	68-12-2	6.1E+03	n	6.2E+04	n	3.1E+01	n	1.3E+02	n	1.6E+03	n		3.2E-01	
Dimethylhydrazine, 1,1-	57-14-7	6.1E+00	n	6.1E+01	n	2.1E-03	n	8.8E-03	n	1.6E+00	n		3.5E-04	
Dimethylhydrazine, 1,2-	540-73-8	8.8E-04	c	3.1E-03	c	1.5E-05	c	7.7E-05	c	1.2E-04	c		2.8E-08	
Dimethylphenol, 2,4-	105-67-9	1.2E+03	n	1.2E+04	n					2.7E+02	n		3.2E-01	
Dimethylphenol, 2,6-	576-26-1	3.7E+01	n	3.7E+02	n					8.1E+00	n		9.8E-03	
Dimethylphenol, 3,4-	95-65-8	6.1E+01	n	6.2E+02	n					1.4E+01	n		1.6E-02	
Dimethylterephthalate	120-61-6	7.8E+03	ns	1.0E+05	nms					1.4E+03	n		3.8E-01	
Dimethylvinylchloride	513-37-1	1.1E+01	c	3.8E+01	c	1.9E-01	c	9.4E-01	c	1.5E+00	c		9.2E-04	
Dinitro-o-cresol, 4,6-	534-52-1	4.9E+00	n	4.9E+01	n					1.2E+00	n		2.0E-03	
Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5	1.2E+02	n	1.2E+03	n					1.7E+01	n		5.7E-01	
Dinitrobenzene, 1,2-	528-29-0	6.1E+00	n	6.2E+01	n					1.5E+00	n		1.4E-03	
Dinitrobenzene, 1,3-	99-65-0	6.1E+00	n	6.2E+01	n					1.5E+00	n		1.4E-03	
Dinitrobenzene, 1,4-	100-25-4	6.1E+00	n	6.2E+01	n					1.5E+00	n		1.4E-03	
Dinitrophenol, 2,4-	51-28-5	1.2E+02	n	1.2E+03	n					3.0E+01	n		3.4E-02	
Dinitrotoluene Mixture, 2,4/2,6-	25321-14-6	7.2E-01	c	2.5E+00	c					9.2E-02	c		1.3E-04	
Dinitrotoluene, 2,4-	121-14-2	1.6E+00	c*	5.5E+00	c	2.7E-02	c	1.4E-01	c	2.0E-01	c		2.8E-04	
Dinitrotoluene, 2,6-	606-20-2	6.1E+01	n	6.2E+02	n					1.5E+01	n		2.0E-02	
Dinitrotoluene, 2-Amino-4,6-	35572-78-2	1.5E+02	n	2.0E+03	n					3.0E+01	n		2.3E-02	
Dinitrotoluene, 4-Amino-2,6-	19406-51-0	1.5E+02	n	1.9E+03	n					3.0E+01	n		2.3E-02	
Dinoseb	88-85-7	6.1E+01	n	6.2E+02	n					1.1E+01	n	7.0E+00	9.8E-02	6.2E-02
Dioxane, 1,4-	123-91-1	4.9E+00	c	1.7E+01	c	3.2E-01	c	1.6E+00	c	6.7E-01	c		1.4E-04	
Dioxins														
~Hexachlorodibenzo-p-dioxin, Mixture	NA	9.4E-05	c	3.9E-04	c	1.9E-06	c	9.4E-06	c	1.1E-05	c		1.5E-05	
~TCDD, 2,3,7,8-	1746-01-6	4.5E-06	c*	1.8E-05	c*	6.4E-08	c	3.2E-07	c	5.2E-07	c*	3.0E-05	2.6E-07	1.5E-05
Diphenamid	957-51-7	1.8E+03	n	1.8E+04	n					4.7E+02	n		4.6E+00	
Diphenyl Sulfone	127-63-9	4.9E+01	n	4.9E+02	n					1.1E+01	n		2.8E-02	
Diphenylamine	122-39-4	1.5E+03	n	1.5E+04	n					2.4E+02	n		4.4E-01	
Diphenylhydrazine, 1,2-	122-66-7	6.1E-01	c	2.2E+00	c	1.1E-02	c	5.6E-02	c	6.7E-02	c		2.2E-04	
Diquat	85-00-7	1.3E+02	n	1.4E+03	n					3.4E+01	n	2.0E+01	6.5E-01	3.7E-01
Direct Black 38	1937-37-7	6.6E-02	c	2.3E-01	c	1.2E-03	c	5.8E-03	c	9.1E-03	c		4.4E+00	
Direct Blue 6	2602-46-2	6.6E-02	c	2.3E-01	c	1.2E-03	c	5.8E-03	c	9.1E-03	c		1.4E+01	
Direct Brown 95	16071-86-6	7.3E-02	c	2.6E-01	c	1.3E-03	c	6.5E-03	c	1.0E-02	c			
Disulfoton	298-04-4	2.4E+00	n	2.5E+01	n					3.8E-01	n		7.1E-04	
Dithiane, 1,4-	505-29-3	6.1E+02	n	6.2E+03	n					1.5E+02	n		7.6E-02	
Diuron	330-54-1	1.2E+02	n	1.2E+03	n					2.8E+01	n		1.2E-02	
Dodine	2439-10-3	2.4E+02	n	2.5E+03	n					6.2E+01	n		3.2E-01	
EPTC	759-94-4	2.0E+03	ns	2.6E+04	ns					2.9E+02	n		1.5E-01	
Endosulfan	115-29-7	3.7E+02	n	3.7E+03	n					7.8E+01	n		1.1E+00	
Endothall	145-73-3	1.2E+03	n	1.2E+04	n					3.0E+02	n	1.0E+02	7.1E-02	2.4E-02
Endrin	72-20-8	1.8E+01	n	1.8E+02	n					1.7E+00	n	2.0E+00	6.8E-02	8.1E-02

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
Epichlorohydrin	106-89-8	2.0E+01	n	8.8E+01	n	1.0E+00	n	4.4E+00	n	2.0E+00	n		4.5E-04	
Epoxybutane, 1,2-	106-88-7	1.7E+02	n	7.2E+02	n	2.1E+01	n	8.8E+01	n	4.2E+01	n		9.2E-03	
Ethephon	16672-87-0	3.1E+02	n	3.1E+03	n					7.8E+01	n		1.6E-02	
Ethion	563-12-2	3.1E+01	n	3.1E+02	n					3.2E+00	n		6.3E-03	
Ethoxyethanol Acetate, 2-	111-15-9	6.1E+03	n	6.2E+04	n	6.3E+01	n	2.6E+02	n	1.5E+03	n		3.2E-01	
Ethoxyethanol, 2-	110-80-5	2.4E+04	n	2.5E+05	nm	2.1E+02	n	8.8E+02	n	6.2E+03	n		1.3E+00	
Ethyl Acetate	141-78-6	7.0E+04	ns	9.2E+05	nms					1.4E+04	n		2.9E+00	
Ethyl Acrylate	140-88-5	1.3E+01	c	6.0E+01	c					1.4E+00	c		3.0E-04	
Ethyl Chloride	75-00-3	1.5E+04	ns	6.1E+04	ns	1.0E+04	n	4.4E+04	n	2.1E+04	n		5.9E+00	
Ethyl Ether	60-29-7	1.6E+04	ns	2.0E+05	nms					3.1E+03	n		6.8E-01	
Ethyl Methacrylate	97-63-2	1.5E+03	ns	7.5E+03	ns	3.1E+02	n	1.3E+03	n	4.2E+02	n		9.9E-02	
Ethyl-p-nitrophenyl Phosphonate	2104-64-5	6.1E-01	n	6.2E+00	n					6.6E-02	n		2.1E-03	
Ethylbenzene	100-41-4	5.4E+00	c	2.7E+01	c	9.7E-01	c	4.9E+00	c	1.3E+00	c	7.0E+02	1.5E-03	7.8E-01
Ethylene Cyanohydrin	109-78-4	1.8E+03	n	1.8E+04	n					4.7E+02	n		9.5E-02	
Ethylene Diamine	107-15-3	5.5E+03	n	5.5E+04	n					1.4E+03	n		3.2E-01	
Ethylene Glycol	107-21-1	1.2E+05	nm	1.2E+06	nm	4.2E+02	n	1.8E+03	n	3.1E+04	n		6.3E+00	
Ethylene Glycol Monobutyl Ether	111-76-2	6.1E+03	n	6.2E+04	n	1.7E+03	n	7.0E+03	n	1.5E+03	n		3.2E-01	
Ethylene Oxide	75-21-8	1.7E-01	c	8.3E-01	c	2.8E-02	c	1.4E-01	c	4.4E-02	c		9.1E-06	
Ethylene Thiourea	96-45-7	4.9E+00	n	3.8E+01	c**	1.9E-01	c	9.4E-01	c	1.2E+00	n		2.8E-04	
Ethyleneimine	151-56-4	7.5E-03	c	2.7E-02	c	1.3E-04	c	6.5E-04	c	1.0E-03	c		2.2E-07	
Ethylphthalyl Ethyl Glycolate	84-72-0	1.8E+05	nm	1.8E+06	nm					4.5E+04	n		1.0E+02	
Express	101200-48-0	4.9E+02	n	4.9E+03	n					1.3E+02	n		4.9E-02	
Fenamiphos	22224-92-6	1.5E+01	n	1.5E+02	n					3.4E+00	n		3.3E-03	
Fenpropathrin	39515-41-8	1.5E+03	n	1.5E+04	n					4.6E+01	n		2.1E+00	
Fluometuron	2164-17-2	7.9E+02	n	8.0E+03	n					1.9E+02	n		1.4E-01	
Fluoride	16984-48-8	3.1E+03	n	4.1E+04	n	1.4E+01	n	5.7E+01	n	6.2E+02	n		9.3E+01	
Fluorine (Soluble Fluoride)	7782-41-4	4.7E+03	n	6.1E+04	n	1.4E+01	n	5.7E+01	n	9.3E+02	n	4.0E+03	1.4E+02	6.0E+02
Fluridone	59756-60-4	4.9E+03	n	4.9E+04	n					1.1E+03	n		1.3E+02	
Flurprimidol	56425-91-3	1.2E+03	n	1.2E+04	n					2.6E+02	n		1.2E+00	
Flutolanil	66332-96-5	3.7E+03	n	3.7E+04	n					7.2E+02	n		3.9E+00	
Fluvalinate	69409-94-5	6.1E+02	n	6.2E+03	n					1.6E+02	n		2.3E+02	
Folpet	133-07-3	1.4E+02	c*	4.9E+02	c					1.7E+01	c*		4.1E-03	
Fomesafen	72178-02-0	2.6E+00	c	9.1E+00	c					3.4E-01	c		1.1E-03	
Fonofos	944-22-9	1.2E+02	n	1.2E+03	n					1.8E+01	n		3.5E-02	
Formaldehyde	50-00-0	1.2E+04	n	1.2E+05	nm	1.9E-01	c*	9.4E-01	c*	3.1E+03	n		6.2E-01	
Formic Acid	64-18-6	4.9E+04	n	4.2E+05	nm	3.1E-01	n	1.3E+00	n	1.4E+04	n		2.8E+00	
Fosetyl-AL	39148-24-8	1.8E+05	nm	1.8E+06	nm					4.7E+04	n			
Furans														
~Dibenzofuran	132-64-9	7.8E+01	n	1.0E+03	ns					5.8E+00	n		1.1E-01	
~Furan	110-00-9	7.8E+01	n	1.0E+03	n					1.5E+01	n		5.7E-03	
Furazolidone	67-45-8	1.3E-01	c	4.5E-01	c					1.8E-02	c		3.4E-05	
Furfural	98-01-1	1.8E+02	n	1.8E+03	n	5.2E+01	n	2.2E+02	n	4.6E+01	n		9.9E-03	
Furium	531-82-8	3.2E-01	c	1.1E+00	c	5.7E-03	c	2.9E-02	c	4.4E-02	c		5.9E-05	
Furmecyclox	60568-05-0	1.6E+01	c	5.7E+01	c	2.8E-01	c	1.4E+00	c	9.6E-01	c		1.0E-03	
Glufosinate, Ammonium	77182-82-2	2.4E+01	n	2.5E+02	n					6.3E+00	n		1.4E-03	
Glutaraldehyde	111-30-8	1.1E+05	nm	4.8E+05	nm	8.3E-02	n	3.5E-01	n					
Glycidyl	765-34-4	2.4E+01	n	2.5E+02	n	1.0E+00	n	4.4E+00	n	6.3E+00	n		1.3E-03	
Glyphosate	1071-83-6	6.1E+03	n	6.2E+04	n					1.6E+03	n	7.0E+02	3.2E-01	1.4E-01
Goal	42874-03-3	1.8E+02	n	1.8E+03	n					2.4E+01	n		1.9E+00	
Guthion	86-50-0	1.8E+02	n	1.8E+03	n	1.0E+01	n	4.4E+01	n	4.3E+01	n		1.3E-02	
Haloxyfop, Methyl	69806-40-2	3.1E+00	n	3.1E+01	n					5.8E-01	n		6.4E-03	
Harmony	79277-27-3	7.9E+02	n	8.0E+03	n					2.0E+02	n		6.1E-02	
Heptachlor	76-44-8	1.1E-01	c	3.8E-01	c	1.9E-03	c	9.4E-03	c	1.8E-03	c	4.0E-01	1.4E-04	3.3E-02
Heptachlor Epoxide	1024-57-3	5.3E-02	c*	1.9E-01	c*	9.4E-04	c	4.7E-03	c	3.3E-03	c*	2.0E-01	6.8E-05	4.1E-03
Hexabromobenzene	87-82-1	1.2E+02	n	1.2E+03	n					3.1E+01	n		1.8E-01	
Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2	1.2E+01	n	1.2E+02	n					3.1E+00	n			
Hexachlorobenzene	118-74-1	3.0E-01	c	1.1E+00	c	5.3E-03	c	2.7E-02	c	4.2E-02	c	1.0E+00	5.3E-04	1.3E-02
Hexachlorobutadiene	87-68-3	6.2E+00	c**	2.2E+01	c*	1.1E-01	c	5.6E-01	c	2.6E-01	c*		5.0E-04	

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
Hexachlorocyclohexane, Alpha-	319-84-6	7.7E-02	c	2.7E-01	c	1.4E-03	c	6.8E-03	c	6.2E-03	c		3.6E-05	
Hexachlorocyclohexane, Beta-	319-85-7	2.7E-01	c	9.6E-01	c	4.6E-03	c	2.3E-02	c	2.2E-02	c		1.3E-04	
Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	5.2E-01	c*	2.1E+00	c	7.8E-03	c	4.0E-02	c	3.6E-02	c*	2.0E-01	2.1E-04	1.2E-03
Hexachlorocyclohexane, Technical	608-73-1	2.7E-01	c	9.6E-01	c	4.8E-03	c	2.4E-02	c	2.2E-02	c		1.3E-04	
Hexachlorocyclopentadiene	77-47-4	3.7E+02	n	3.7E+03	n	2.1E-01	n	8.8E-01	n	2.2E+01	n	5.0E+01	7.0E-02	1.6E-01
Hexachloroethane	67-72-1	1.2E+01	c**	4.3E+01	c*	2.2E-01	c	1.1E+00	c	7.9E-01	c**		4.8E-04	
Hexachlorophene	70-30-4	1.8E+01	n	1.8E+02	n					4.7E+00	n		6.3E+00	
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	5.6E+00	c*	2.4E+01	c					6.1E-01	c*		2.3E-04	
Hexamethylene Diisocyanate, 1,6-	822-06-0	3.4E+00	n	1.4E+01	n	1.0E-02	n	4.4E-02	n	2.1E-02	n		2.1E-04	
Hexane, N-	110-54-3	5.7E+02	ns	2.6E+03	ns	7.3E+02	n	3.1E+03	n	2.5E+02	n		1.8E+00	
Hexanedioic Acid	124-04-9	1.2E+05	nm	1.2E+06	nm					3.1E+04	n		7.7E+00	
Hexanone, 2-	591-78-6	2.1E+02	n	1.4E+03	n	3.1E+01	n	1.3E+02	n	3.4E+01	n		7.9E-03	
Hexazinone	51235-04-2	2.0E+03	n	2.0E+04	n					5.0E+02	n		2.3E-01	
Hydrazine	302-01-2	2.1E-01	c	9.5E-01	c	5.0E-04	c*	2.5E-03	c*	2.2E-02	c			
Hydrazine Sulfate	10034-93-2	2.1E-01	c	9.5E-01	c	5.0E-04	c	2.5E-03	c	2.2E-02	c			
Hydrogen Chloride	7647-01-0	2.8E+07	nm	1.2E+08	nm	2.1E+01	n	8.8E+01	n					
Hydrogen Fluoride	7664-39-3	3.1E+03	n	4.1E+04	n	1.5E+01	n	6.1E+01	n	6.2E+02	n			
Hydrogen Sulfide	7783-06-4	2.8E+06	nm	1.2E+07	nm	2.1E+00	n	8.8E+00	n					
Hydroquinone	123-31-9	8.1E+00	c	2.9E+01	c					1.1E+00	c		7.5E-04	
Imazalil	35554-44-0	7.9E+02	n	8.0E+03	n					1.4E+02	n		2.5E+00	
Imazaquin	81335-37-7	1.5E+04	n	1.5E+05	nm					3.8E+03	n		1.9E+01	
Iodine	7553-56-2	7.8E+02	n	1.0E+04	n					1.6E+02	n		9.4E+00	
Iprodione	36734-19-7	2.4E+03	n	2.5E+04	n					5.7E+02	n		1.7E-01	
Iron	7439-89-6	5.5E+04	n	7.2E+05	nm					1.1E+04	n		2.7E+02	
Isobutyl Alcohol	78-83-1	2.3E+04	ns	3.1E+05	nms					4.6E+03	n		9.5E-01	
Isophorone	78-59-1	5.1E+02	c*	1.8E+03	c*	2.1E+03	n	8.8E+03	n	6.7E+01	c*		2.2E-02	
Isopropalin	33820-53-0	9.2E+02	n	9.2E+03	n					2.3E+02	n		5.4E+00	
Isopropanol	67-63-0	9.9E+09	nm	4.2E+10	nm	7.3E+03	n	3.1E+04	n					
Isopropyl Methyl Phosphonic Acid	1832-54-8	6.1E+03	n	6.2E+04	n					1.6E+03	n		3.4E-01	
Isoxaben	82558-50-7	3.1E+03	n	3.1E+04	n					5.6E+02	n		1.5E+00	
JP-7	NA	4.3E+08	nm	1.8E+09	nm	3.1E+02	n	1.3E+03	n	6.3E+02	n			
Kerb	23950-58-5	4.6E+03	n	4.6E+04	n					9.0E+02	n		9.1E-01	
Lactofen	77501-63-4	1.2E+02	n	1.2E+03	n					1.9E+01	n		8.7E-01	
Lead Compounds														
~Lead acetate	301-04-2	1.7E+00	c	6.2E+00	c	3.0E-02	c	1.5E-01	c	2.4E-01	c			
~Lead and Compounds	7439-92-1	4.0E+02	n	8.0E+02	n							1.5E+01		1.4E+01
~Lead subacetate	1335-32-6	1.3E+01	c	4.5E+01	c	2.2E-01	c	1.1E+00	c	1.8E+00	c			
~Tetraethyl Lead	78-00-2	6.1E-03	n	6.2E-02	n					9.9E-04	n		3.5E-06	
Linuron	330-55-2	1.2E+02	n	1.2E+03	n					2.6E+01	n		2.3E-02	
Lithium	7439-93-2	1.6E+02	n	2.0E+03	n					3.1E+01	n		9.3E+00	
Londax	83055-99-6	1.2E+04	n	1.2E+05	nm					3.1E+03	n		7.9E-01	
MCPA	94-74-6	3.1E+01	n	3.1E+02	n					5.7E+00	n		1.5E-03	
MCPB	94-81-5	6.1E+02	n	6.2E+03	n					1.6E+02	n		6.2E-02	
MCPP	93-65-2	6.1E+01	n	6.2E+02	n					1.2E+01	n		3.5E-03	
Malathion	121-75-5	1.2E+03	n	1.2E+04	n					3.0E+02	n		7.9E-02	
Maleic Anhydride	108-31-6	6.1E+03	n	6.1E+04	n	7.3E-01	n	3.1E+00	n	1.5E+03	n		3.0E-01	
Maleic Hydrazide	123-33-1	3.1E+04	n	3.1E+05	nm					7.8E+03	n		1.6E+00	
Malononitrile	109-77-3	6.1E+00	n	6.2E+01	n					1.6E+00	n		3.2E-04	
Mancozeb	8018-01-7	1.8E+03	n	1.8E+04	n					4.7E+02	n		6.6E-01	
Maneb	12427-38-2	3.1E+02	n	3.1E+03	n					7.8E+01	n		1.1E-01	
Manganese (Diet)	7439-96-5													
Manganese (Non-diet)	7439-96-5	1.8E+03	n	2.3E+04	n	5.2E-02	n	2.2E-01	n	3.2E+02	n		2.1E+01	
Mephosfolan	950-10-7	5.5E+00	n	5.5E+01	n					1.4E+00	n		2.1E-03	
Mepiquat Chloride	24307-26-4	1.8E+03	n	1.8E+04	n					4.7E+02	n		1.6E-01	
Mercury Compounds														
~Mercuric Chloride (and other Mercury salts)	7487-94-7	2.3E+01	n	3.1E+02	n	3.1E-02	n	1.3E-01	n	4.3E+00	n	2.0E+00		
~Mercury (elemental)	7439-97-6	1.0E+01	ns	4.3E+01	ns	3.1E-01	n	1.3E+00	n	6.3E-01	n	2.0E+00	3.3E-02	1.0E-01
~Methyl Mercury	22967-92-6	7.8E+00	n	1.0E+02	n					1.6E+00	n			

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~Phenylmercuric Acetate	62-38-4	4.9E+00	n	4.9E+01	n					1.2E+00	n		3.9E-04	
Merphos	150-50-5	1.8E+00	n	1.8E+01	n					4.7E-01	n		4.6E-02	
Merphos Oxide	78-48-8	1.8E+00	n	1.8E+01	n					6.1E-02	n		3.0E-04	
Metalaxyl	57837-19-1	3.7E+03	n	3.7E+04	n					9.2E+02	n		2.5E-01	
Methacrylonitrile	126-98-7	3.2E+00	n	1.8E+01	n	7.3E-01	n	3.1E+00	n	7.5E-01	n		1.7E-04	
Methamidophos	10265-92-6	3.1E+00	n	3.1E+01	n					7.8E-01	n		1.6E-04	
Methanol	67-56-1	3.1E+04	n	3.1E+05	nm	4.2E+03	n	1.8E+04	n	7.8E+03	n		1.6E+00	
Methidathion	950-37-8	6.1E+01	n	6.2E+02	n					1.5E+01	n		3.7E-03	
Methomyl	16752-77-5	1.5E+03	n	1.5E+04	n					3.9E+02	n		8.5E-02	
Methoxy-5-nitroaniline, 2-	99-59-2	9.9E+00	c	3.5E+01	c	1.7E-01	c	8.8E-01	c	1.3E+00	c		4.6E-04	
Methoxychlor	72-43-5	3.1E+02	n	3.1E+03	n					2.7E+01	n	4.0E+01	1.5E+00	2.2E+00
Methoxyethanol Acetate, 2-	110-49-6	4.9E+02	n	4.9E+03	n	1.0E+00	n	4.4E+00	n	1.3E+02	n		2.6E-02	
Methoxyethanol, 2-	109-86-4	3.1E+02	n	3.1E+03	n	2.1E+01	n	8.8E+01	n	7.8E+01	n		1.6E-02	
Methyl Acetate	79-20-9	7.8E+04	ns	1.0E+06	nms					1.6E+04	n		3.2E+00	
Methyl Acrylate	96-33-3	2.3E+03	n	3.1E+04	ns					4.6E+02	n		9.8E-02	
Methyl Ethyl Ketone (2-Butanone)	78-93-3	2.8E+04	n	2.0E+05	nms	5.2E+03	n	2.2E+04	n	4.9E+03	n		1.0E+00	
Methyl Hydrazine	60-34-4	6.1E+01	n	6.1E+02	n	2.4E-03	c**	1.2E-02	c**	1.6E+01	n		3.5E-03	
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	5.3E+03	ns	5.3E+04	ns	3.1E+03	n	1.3E+04	n	1.0E+03	n		2.3E-01	
Methyl Isocyanate	624-83-9	1.4E+06	nm	6.0E+06	nm	1.0E+00	n	4.4E+00	n					
Methyl Methacrylate	80-62-6	4.8E+03	ns	2.1E+04	ns	7.3E+02	n	3.1E+03	n	1.4E+03	n		3.0E-01	
Methyl Parathion	298-00-0	1.5E+01	n	1.5E+02	n					3.4E+00	n		5.7E-03	
Methyl Phosphonic Acid	993-13-5	3.7E+03	n	3.7E+04	n					9.4E+02	n		1.9E-01	
Methyl Styrene (Mixed Isomers)	25013-15-4	2.5E+02	n	1.6E+03	ns	4.2E+01	n	1.8E+02	n	3.1E+01	n		5.0E-02	
Methyl methanesulfonate	66-27-3	4.9E+00	c	1.7E+01	c	8.7E-02	c	4.4E-01	c	6.8E-01	c		1.4E-04	
Methyl tert-Butyl Ether (MTBE)	1634-04-4	4.3E+01	c	2.2E+02	c	9.4E+00	c	4.7E+01	c	1.2E+01	c		2.8E-03	
Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2	1.2E+01	n	1.2E+02	n					3.1E+00	n		1.9E-03	
Methyl-5-Nitroaniline, 2-	99-55-8	5.4E+01	c*	1.9E+02	c*					7.0E+00	c*		3.9E-03	
Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	5.9E-02	c	2.1E-01	c	1.0E-03	c	5.1E-03	c	8.1E-03	c		2.8E-06	
Methylaniline Hydrochloride, 2-	636-21-5	3.7E+00	c	1.3E+01	c	6.6E-02	c	3.3E-01	c	5.0E-01	c		2.1E-04	
Methylarsonic acid	124-58-3	6.1E+02	n	6.2E+03	n					1.6E+02	n			
Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7	1.2E+01	n	1.2E+02	n					3.1E+00	n			
Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	1.2E+01	n	1.2E+02	n					3.1E+00	n			
Methylcholanthrene, 3-	56-49-5	5.2E-03	c	7.8E-02	c	1.5E-04	c	1.9E-03	c	9.8E-04	c		1.9E-03	
Methylene Chloride	75-09-2	1.1E+01	c	5.3E+01	c	5.2E+00	c	2.6E+01	c	4.7E+00	c	5.0E+00	1.2E-03	1.3E-03
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	1.2E+00	c	1.7E+01	c*	2.2E-03	c	2.9E-02	c	1.4E-01	c		1.6E-03	
Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	1.1E+01	c	3.7E+01	c	1.9E-01	c	9.4E-01	c	6.0E-01	c		3.3E-03	
Methylenebisbenzenamine, 4,4'-	101-77-9	3.0E-01	c	1.1E+00	c	5.3E-03	c	2.7E-02	c	4.1E-02	c		1.8E-04	
Methylenediphenyl Diisocyanate	101-68-8	8.5E+05	nm	3.6E+06	nm	6.3E-01	n	2.6E+00	n					
Methylstyrene, Alpha-	98-83-9	5.5E+03	ns	7.2E+04	ns					5.8E+02	n		9.3E-01	
Metolachlor	51218-45-2	9.2E+03	n	9.2E+04	n					2.1E+03	n		2.5E+00	
Metribuzin	21087-64-9	1.5E+03	n	1.5E+04	n					3.8E+02	n		1.2E-01	
Mineral oils	8012-95-1	1.8E+05	nm	1.8E+06	nm					4.7E+04	n		1.9E+03	
Mirex	2385-85-5	2.7E-02	c	9.6E-02	c	4.8E-04	c	2.4E-03	c	3.7E-03	c		2.7E-03	
Molinate	2212-67-1	1.2E+02	n	1.2E+03	n					2.3E+01	n		1.3E-02	
Molybdenum	7439-98-7	3.9E+02	n	5.1E+03	n					7.8E+01	n		1.6E+00	
Monochloramine	10599-90-3	7.8E+03	n	1.0E+05	nm					1.6E+03	n			
Monomethylaniline	100-61-8	1.2E+02	n	1.2E+03	n					3.0E+01	n		1.1E-02	
N,N'-Diphenyl-1,4-benzenediamine	74-31-7	1.8E+01	n	1.8E+02	n					2.7E+00	n		2.8E-01	
Naled	300-76-5	1.2E+02	n	1.2E+03	n					3.1E+01	n		1.4E-02	
Naphtha, High Flash Aromatic (HFAN)	64724-95-6	2.3E+03	n	3.1E+04	n	1.0E+02	n	4.4E+02	n	1.4E+02	n			
Naphthylamine, 2-	91-59-8	2.7E-01	c	9.6E-01	c					3.3E-02	c		1.7E-04	
Napropamide	15299-99-7	6.1E+03	n	6.2E+04	n					1.3E+03	n		8.3E+00	
Nickel Carbonyl	13463-39-3	3.7E+03	n	4.4E+04	n	5.2E-02	n	2.2E-01	n	6.7E+02	n			
Nickel Oxide	1313-99-1	3.8E+03	n	4.7E+04	n	1.0E-01	n	4.4E-01	n	7.8E+02	n			
Nickel Refinery Dust	NA	3.7E+03	n	4.4E+04	n	1.0E-02	c**	5.1E-02	c**	7.6E+02	n		1.1E+02	
Nickel Soluble Salts	7440-02-0	1.5E+03	n	2.0E+04	n	9.4E-03	c*	4.7E-02	c**	3.0E+02	n		2.0E+01	
Nickel Subsulfide	12035-72-2	3.8E-01	c	1.7E+00	c	5.1E-03	c*	2.6E-02	c**	3.9E-02	c			
Nitrate	14797-55-8	1.3E+05	nm	1.6E+06	nm					2.5E+04	n	1.0E+04		

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
Nitrite	14797-65-0	7.8E+03	n	1.0E+05	nm					1.6E+03	n	1.0E+03		
Nitroaniline, 2-	88-74-4	6.1E+02	n	6.0E+03	n	5.2E-02	n	2.2E-01	n	1.5E+02	n		6.2E-02	
Nitroaniline, 4-	100-01-6	2.4E+01	c*	8.6E+01	c*	6.3E+00	n	2.6E+01	n	3.3E+00	c*		1.4E-03	
Nitrobenzene	98-95-3	4.8E+00	c*	2.4E+01	c*	6.1E-02	c	3.1E-01	c	1.2E-01	c*		7.9E-05	
Nitrocellulose	9004-70-0	1.8E+08	nm	1.8E+09	nm					4.7E+07	n		1.0E+04	
Nitrofurantoin	67-20-9	4.3E+03	n	4.3E+04	n					1.1E+03	n		4.7E-01	
Nitrofurazone	59-87-0	3.7E-01	c	1.3E+00	c	6.6E-03	c	3.3E-02	c	5.2E-02	c		4.6E-05	
Nitroglycerin	55-63-0	6.1E+00	n	6.2E+01	n					1.5E+00	n		6.6E-04	
Nitroguanidine	556-88-7	6.1E+03	n	6.2E+04	n					1.6E+03	n		3.8E-01	
Nitromethane	75-52-5	4.9E+00	c*	2.5E+01	c*	2.7E-01	c*	1.4E+00	c*	5.4E-01	c*		1.2E-04	
Nitropropane, 2-	79-46-9	1.3E-02	c	6.4E-02	c	9.0E-04	c	4.5E-03	c	1.8E-03	c		4.7E-07	
Nitroso-N-ethylurea, N-	759-73-9	4.3E-03	c	6.4E-02	c	1.2E-04	c	1.6E-03	c	7.9E-04	c		1.9E-07	
Nitroso-N-methylurea, N-	684-93-5	9.6E-04	c	1.4E-02	c	2.8E-05	c	3.6E-04	c	1.8E-04	c		4.0E-08	
Nitroso-di-N-butylamine, N-	924-16-3	8.7E-02	c	4.0E-01	c	1.5E-03	c	7.7E-03	c	2.4E-03	c		4.8E-06	
Nitroso-di-N-propylamine, N-	621-64-7	6.9E-02	c	2.5E-01	c	1.2E-03	c	6.1E-03	c	9.3E-03	c		7.0E-06	
Nitrosodiethanolamine, N-	1116-54-7	1.7E-01	c	6.2E-01	c	3.0E-03	c	1.5E-02	c	2.4E-02	c		4.8E-06	
Nitrosodiethylamine, N-	55-18-5	7.7E-04	c	1.1E-02	c	2.2E-05	c	2.9E-04	c	1.4E-04	c		5.2E-08	
Nitrosodimethylamine, N-	62-75-9	2.3E-03	c	3.4E-02	c	6.9E-05	c	8.8E-04	c	4.2E-04	c		1.0E-07	
Nitrosodiphenylamine, N-	86-30-6	9.9E+01	c	3.5E+02	c	9.4E-01	c	4.7E+00	c	1.0E+01	c		5.7E-02	
Nitrosomethylethylamine, N-	10595-95-6	2.2E-02	c	7.8E-02	c	3.9E-04	c	1.9E-03	c	3.0E-03	c		8.7E-07	
Nitrosomorpholine [N-]	59-89-2	7.3E-02	c	2.6E-01	c	1.3E-03	c	6.5E-03	c	1.0E-02	c		2.5E-06	
Nitrosopiperidine [N-]	100-75-4	5.2E-02	c	1.8E-01	c	9.0E-04	c	4.5E-03	c	7.1E-03	c		3.8E-06	
Nitrosopyrrolidine, N-	930-55-2	2.3E-01	c	8.2E-01	c	4.0E-03	c	2.0E-02	c	3.2E-02	c		1.2E-05	
Nitrotoluene, m-	99-08-1	6.1E+00	n	6.2E+01	n					1.3E+00	n		1.2E-03	
Nitrotoluene, o-	88-72-2	2.9E+00	c*	1.3E+01	c*					2.7E-01	c*		2.5E-04	
Nitrotoluene, p-	99-99-0	3.0E+01	c**	1.1E+02	c*					3.7E+00	c*		3.4E-03	
Nonane, n-	111-84-2	2.1E+01	ns	2.3E+02	ns	2.1E+02	n	8.8E+02	n	4.6E+00	n		6.6E-02	
Norflurazon	27314-13-2	2.4E+03	n	2.5E+04	n					6.0E+02	n		3.9E+00	
Nustar	85509-19-9	4.3E+01	n	4.3E+02	n					8.3E+00	n		1.4E+00	
Octabromodiphenyl Ether	32536-52-0	1.8E+02	n	1.8E+03	n					4.7E+01	n		9.3E+00	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0	3.8E+03	n	4.9E+04	n					7.8E+02	n		9.9E-01	
Octamethylpyrophosphoramide	152-16-9	1.2E+02	n	1.2E+03	n					3.1E+01	n		7.5E-03	
Oryzalin	19044-88-3	3.1E+03	n	3.1E+04	n					6.2E+02	n		1.1E+00	
Oxadiazon	19666-30-9	3.1E+02	n	3.1E+03	n					3.5E+01	n		3.6E-01	
Oxamyl	23135-22-0	1.5E+03	n	1.5E+04	n					3.9E+02	n	2.0E+02	8.6E-02	4.4E-02
Paclobutrazol	76738-62-0	7.9E+02	n	8.0E+03	n					1.7E+02	n		3.6E-01	
Paraquat Dichloride	1910-42-5	2.7E+02	n	2.8E+03	n					7.0E+01	n		9.7E-01	
Parathion	56-38-2	3.7E+02	n	3.7E+03	n					6.5E+01	n		3.3E-01	
Pebulate	1114-71-2	3.1E+03	n	3.1E+04	n					4.2E+02	n		3.3E-01	
Pendimethalin	40487-42-1	2.4E+03	n	2.5E+04	n					1.3E+02	n		1.5E+00	
Pentabromodiphenyl Ether	32534-81-9	1.2E+02	n	1.2E+03	n					3.1E+01	n		1.4E+00	
Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9	6.1E+00	n	6.2E+01	n					1.6E+00	n		6.8E-02	
Pentachlorobenzene	608-93-5	4.9E+01	n	4.9E+02	n					2.3E+00	n		1.7E-02	
Pentachloroethane	76-01-7	5.4E+00	c	1.9E+01	c					5.6E-01	c		2.7E-04	
Pentachloronitrobenzene	82-68-8	1.9E+00	c*	6.6E+00	c					1.0E-01	c		1.3E-03	
Pentachlorophenol	87-86-5	8.9E-01	c	2.7E+00	c	4.8E-01	c	2.4E+00	c	1.7E-01	c	1.0E+00	1.7E-03	1.0E-02
Pentaerythritol tetranitrate (PETN)	78-11-5	1.2E+02	c**	4.3E+02	c**					1.6E+01	c**		2.4E-02	
Pentane, n-	109-66-0	8.7E+02	ns	3.7E+03	ns	1.0E+03	n	4.4E+03	n	2.1E+03	n		1.0E+01	
Perchlorates														
~Ammonium Perchlorate	7790-98-9	5.5E+01	n	7.2E+02	n					1.1E+01	n			
~Lithium Perchlorate	7791-03-9	5.5E+01	n	7.2E+02	n					1.1E+01	n			
~Perchlorate and Perchlorate Salts	14797-73-0	5.5E+01	n	7.2E+02	n					1.1E+01	n	1.5E+01(F		
~Potassium Perchlorate	7778-74-7	5.5E+01	n	7.2E+02	n					1.1E+01	n			
~Sodium Perchlorate	7601-89-0	5.5E+01	n	7.2E+02	n					1.1E+01	n			
Permethrin	52645-53-1	3.1E+03	n	3.1E+04	n					7.8E+02	n		1.9E+02	
Phenacetin	62-44-2	2.2E+02	c	7.8E+02	c	3.9E+00	c	1.9E+01	c	3.0E+01	c		8.3E-03	
Phenmedipham	13684-63-4	1.5E+04	n	1.5E+05	nm					3.0E+03	n		1.6E+01	
Phenol	108-95-2	1.8E+04	n	1.8E+05	nm	2.1E+02	n	8.8E+02	n	4.5E+03	n		2.6E+00	

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Phenothiazine	92-84-2	3.1E+01	n	3.1E+02	n					3.2E+00	n		1.0E-02	
Phenylenediamine, m-	108-45-2	3.7E+02	n	3.7E+03	n					9.4E+01	n		2.5E-02	
Phenylenediamine, o-	95-54-5	1.0E+01	c	3.7E+01	c					1.4E+00	c		3.8E-04	
Phenylenediamine, p-	106-50-3	1.2E+04	n	1.2E+05	nm					3.0E+03	n		7.9E-01	
Phenylphenol, 2-	90-43-7	2.5E+02	c	8.9E+02	c					2.6E+01	c		3.5E-01	
Phorate	298-02-2	1.2E+01	n	1.2E+02	n					2.3E+00	n		2.6E-03	
Phosgene	75-44-5	3.3E-01	n	1.4E+00	n	3.1E-01	n	1.3E+00	n					
Phosmet	732-11-6	1.2E+03	n	1.2E+04	n					2.9E+02	n		6.4E-02	
Phosphates, Inorganic														
~Aluminum metaphosphate	13776-88-0	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Ammonium polyphosphate	68333-79-9	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Calcium pyrophosphate	7790-76-3	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Diammonium phosphate	7783-28-0	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Dicalcium phosphate	7757-93-9	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Dimagnesium phosphate	7782-75-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Dipotassium phosphate	7758-11-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Disodium phosphate	7558-79-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Monoaluminum phosphate	13530-50-2	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Monoammonium phosphate	7722-76-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Monocalcium phosphate	7758-23-8	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Monomagnesium phosphate	7757-86-0	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Monopotassium phosphate	7778-77-0	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Monosodium phosphate	7558-80-7	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Polyphosphoric acid	8017-16-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Potassium tripolyphosphate	13845-36-8	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Sodium acid pyrophosphate	7758-16-9	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Sodium aluminum phosphate (acidic)	7785-88-8	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Sodium aluminum phosphate (anhydrous)	10279-59-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Sodium aluminum phosphate (tetrahydrate)	10305-76-7	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Sodium hexametaphosphate	10124-56-8	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Sodium polyphosphate	68915-31-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Sodium trimetaphosphate	7785-84-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Sodium tripolyphosphate	7758-29-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Tetrapotassium phosphate	7320-34-5	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Tetrasodium pyrophosphate	7722-88-5	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Trialuminum sodium tetra	15136-87-5	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Tricalcium phosphate	7758-87-4	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Trimagnesium phosphate	7757-87-1	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Tripotassium phosphate	7778-53-2	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
~Trisodium phosphate	7601-54-9	3.8E+06	nm	5.0E+07	nm					7.6E+05	n			
Phosphine	7803-51-2	2.3E+01	n	3.1E+02	n	3.1E-01	n	1.3E+00	n	4.7E+00	n			
Phosphoric Acid	7664-38-2	3.0E+06	nm	2.7E+07	nm	1.0E+01	n	4.4E+01	n	7.6E+05	n			
Phosphorus, White	7723-14-0	1.6E+00	n	2.0E+01	n					3.1E-01	n		1.1E-03	
Phthalic Acid, P-	100-21-0	6.1E+04	n	6.2E+05	nm					1.5E+04	n		5.3E+00	
Phthalic Anhydride	85-44-9	1.2E+05	nm	1.2E+06	nm	2.1E+01	n	8.8E+01	n	3.0E+04	n		6.6E+00	
Picloram	1918-02-1	4.3E+03	n	4.3E+04	n					1.1E+03	n	5.0E+02	2.9E-01	1.4E-01
Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3	6.1E+00	n	6.2E+01	n					1.5E+00	n		1.0E-03	
Pirimiphos, Methyl	29232-93-7	6.1E+02	n	6.2E+03	n					9.1E+01	n		8.7E-02	
Polybrominated Biphenyls	59536-65-1	1.6E-02	c*	5.7E-02	c*	2.8E-04	c	1.4E-03	c	2.2E-03	c*			
Polychlorinated Biphenyls (PCBs)														
~Aroclor 1016	12674-11-2	3.9E+00	n	2.1E+01	c**	1.2E-01	c	6.1E-01	c	9.6E-01	c**		9.2E-02	
~Aroclor 1221	11104-28-2	1.4E-01	c	5.4E-01	c	4.3E-03	c	2.1E-02	c	4.3E-03	c		7.4E-05	
~Aroclor 1232	11141-16-5	1.4E-01	c	5.4E-01	c	4.3E-03	c	2.1E-02	c	4.3E-03	c		7.4E-05	
~Aroclor 1242	53469-21-9	2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		5.3E-03	
~Aroclor 1248	12672-29-6	2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		5.2E-03	
~Aroclor 1254	11097-69-1	2.2E-01	c**	7.4E-01	c*	4.3E-03	c	2.1E-02	c	3.4E-02	c**		8.8E-03	
~Aroclor 1260	11096-82-5	2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c	3.4E-02	c		2.4E-02	
~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		1.2E-02	

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~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		7.2E-03	
~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		7.4E-03	
~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		7.4E-03	
~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	1.1E-04	c*	3.8E-04	c*	2.1E-06	c	1.1E-05	c	1.7E-05	c*		7.2E-06	
~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		4.5E-03	
~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		4.4E-03	
~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		4.5E-03	
~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	1.1E-01	c*	3.8E-01	c*	2.1E-03	c	1.1E-02	c	1.7E-02	c*		4.5E-03	
~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	3.4E-05	c*	1.1E-04	c*	6.4E-07	c	3.2E-06	c	5.2E-06	c*		1.3E-06	
~Polychlorinated Biphenyls (high risk)	1336-36-3	2.2E-01	c	7.4E-01	c	4.3E-03	c	2.1E-02	c					
~Polychlorinated Biphenyls (low risk)	1336-36-3					2.4E-02	c	1.2E-01	c	1.7E-01	c	5.0E-01	2.6E-02	7.8E-02
~Polychlorinated Biphenyls (lowest risk)	1336-36-3					1.2E-01	c	6.1E-01	c					
~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	3.4E-02	c*	1.1E-01	c*	6.4E-04	c	3.2E-03	c	5.2E-03	c*		8.1E-04	
~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	1.1E-02	c*	3.8E-02	c*	2.1E-04	c	1.1E-03	c	1.7E-03	c*		2.7E-04	
Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9	8.5E+05	nm	3.6E+06	nm	6.3E-01	n	2.6E+00	n					
Polynuclear Aromatic Hydrocarbons (PAHs)														
~Acenaphthene	83-32-9	3.4E+03	n	3.3E+04	n					4.0E+02	n		4.1E+00	
~Anthracene	120-12-7	1.7E+04	n	1.7E+05	nm					1.3E+03	n		4.2E+01	
~Benz[a]anthracene	56-55-3	1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		1.0E-02	
~Benzo(j)fluoranthene	205-82-3	3.8E-01	c	1.3E+00	c	2.2E-02	c	1.1E-01	c	5.6E-02	c		6.7E-02	
~Benzo[a]pyrene	50-32-8	1.5E-02	c	2.1E-01	c	8.7E-04	c	1.1E-02	c	2.9E-03	c	2.0E-01	3.5E-03	2.4E-01
~Benzo[b]fluoranthene	205-99-2	1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		3.5E-02	
~Benzo[k]fluoranthene	207-08-9	1.5E+00	c	2.1E+01	c	8.7E-03	c	1.1E-01	c	2.9E-01	c		3.5E-01	
~Chrysene	218-01-9	1.5E+01	c	2.1E+02	c	8.7E-02	c	1.1E+00	c	2.9E+00	c		1.1E+00	
~Dibenz[a,h]anthracene	53-70-3	1.5E-02	c	2.1E-01	c	8.0E-04	c	1.0E-02	c	2.9E-03	c		1.1E-02	
~Dibenzo(a,e)pyrene	192-65-4	3.8E-02	c	1.3E-01	c	2.2E-03	c	1.1E-02	c	5.6E-03	c		7.3E-02	
~Dimethylbenz(a)anthracene, 7,12-	57-97-6	4.3E-04	c	6.2E-03	c	1.4E-05	c	1.7E-04	c	8.6E-05	c		8.5E-05	
~Fluoranthene	206-44-0	2.3E+03	n	2.2E+04	n					6.3E+02	n		7.0E+01	
~Fluorene	86-73-7	2.3E+03	n	2.2E+04	n					2.2E+02	n		4.0E+00	
~Indeno[1,2,3-cd]pyrene	193-39-5	1.5E-01	c	2.1E+00	c	8.7E-03	c	1.1E-01	c	2.9E-02	c		1.2E-01	
~Methylnaphthalene, 1-	90-12-0	2.2E+01	c	9.9E+01	c					9.7E-01	c		5.1E-03	
~Methylnaphthalene, 2-	91-57-6	3.1E+02	n	4.1E+03	ns					2.7E+01	n		1.4E-01	
~Naphthalene	91-20-3	3.6E+00	c*	1.8E+01	c*	7.2E-02	c*	3.6E-01	c*	1.4E-01	c*		4.7E-04	
~Nitropyrene, 4-	57835-92-4	3.8E-01	c	1.3E+00	c	2.2E-02	c	1.1E-01	c	1.6E-02	c		2.8E-03	
~Pyrene	129-00-0	1.7E+03	n	1.7E+04	n					8.7E+01	n		9.5E+00	
Prochloraz	67747-09-5	3.2E+00	c	1.1E+01	c					3.2E-01	c		1.6E-03	
Profluralin	26399-36-0	3.7E+02	n	3.7E+03	n					1.9E+01	n		1.2E+00	
Prometon	1610-18-0	9.2E+02	n	9.2E+03	n					1.9E+02	n		9.2E-02	
Prometryn	7287-19-6	2.4E+02	n	2.5E+03	n					4.5E+01	n		6.9E-02	
Propachlor	1918-16-7	7.9E+02	n	8.0E+03	n					1.9E+02	n		1.2E-01	
Propanil	709-98-8	3.1E+02	n	3.1E+03	n					6.3E+01	n		3.5E-02	
Propargite	2312-35-8	1.2E+03	n	1.2E+04	n					1.2E+02	n		8.8E+00	
Propargyl Alcohol	107-19-7	1.2E+02	n	1.2E+03	n					3.1E+01	n		6.4E-03	
Propazine	139-40-2	1.2E+03	n	1.2E+04	n					2.6E+02	n		2.3E-01	
Propham	122-42-9	1.2E+03	n	1.2E+04	n					2.7E+02	n		1.7E-01	
Propiconazole	60207-90-1	7.9E+02	n	8.0E+03	n					1.6E+02	n		5.3E-01	
Propionaldehyde	123-38-6	8.0E+01	n	3.4E+02	n	8.3E+00	n	3.5E+01	n	1.7E+01	n		3.4E-03	
Propyl benzene	103-65-1	3.4E+03	ns	2.1E+04	ns	1.0E+03	n	4.4E+03	n	5.3E+02	n		9.9E-01	
Propylene	115-07-1	4.3E+09	nm	1.8E+10	nm	3.1E+03	n	1.3E+04	n					
Propylene Glycol	57-55-6	1.2E+06	nm	1.2E+07	nm					3.1E+05	n		6.3E+01	
Propylene Glycol Dinitrate	6423-43-4	5.7E+01	n	2.4E+02	n	2.8E-01	n	1.2E+00	n	5.7E-01	n		1.8E-04	
Propylene Glycol Monoethyl Ether	1569-02-4	4.3E+04	n	4.3E+05	nm					1.1E+04	n		2.2E+00	
Propylene Glycol Monomethyl Ether	107-98-2	4.3E+04	n	4.3E+05	nm	2.1E+03	n	8.8E+03	n	1.1E+04	n		2.2E+00	
Propylene Oxide	75-56-9	2.0E+00	c	9.0E+00	c	6.6E-01	c*	3.3E+00	c*	2.3E-01	c		4.8E-05	
Pursuit	81335-77-5	1.5E+04	n	1.5E+05	nm					3.9E+03	n		3.4E+00	
Pydrin	51630-58-1	1.5E+03	n	1.5E+04	n					3.9E+02	n		2.5E+02	
Pyridine	110-86-1	7.8E+01	n	1.0E+03	n					1.5E+01	n		5.3E-03	
Quinalphos	13593-03-8	3.1E+01	n	3.1E+02	n					3.8E+00	n		3.2E-02	

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
Quinoline	91-22-5	1.6E-01	c	5.7E-01	c					2.1E-02	c		6.8E-05	
Refractory Ceramic Fibers	NA	4.3E+07	nm	1.8E+08	nm	3.1E+01	n	1.3E+02	n					
Resmethrin	10453-86-8	1.8E+03	n	1.8E+04	n					4.8E+01	n		3.0E+01	
Ronnel	299-84-3	3.1E+03	n	3.1E+04	n					3.0E+02	n		2.7E+00	
Rotenone	83-79-4	2.4E+02	n	2.5E+03	n					4.7E+01	n		2.4E+01	
Safrole	94-59-7	5.2E-01	c	7.8E+00	c	1.5E-02	c	1.9E-01	c	6.2E-02	c		3.8E-05	
Savey	78587-05-0	1.5E+03	n	1.5E+04	n					8.1E+01	n		3.6E-01	
Selenious Acid	7783-00-8	3.9E+02	n	5.1E+03	n					7.8E+01	n			
Selenium	7782-49-2	3.9E+02	n	5.1E+03	n	2.1E+01	n	8.8E+01	n	7.8E+01	n	5.0E+01	4.0E-01	2.6E-01
Selenium Sulfide	7446-34-6	3.9E+02	n	5.1E+03	n	2.1E+01	n	8.8E+01	n	7.8E+01	n			
Sethoxydim	74051-80-2	5.5E+03	n	5.5E+04	n					7.8E+02	n		6.9E+00	
Silica (crystalline, respirable)	7631-86-9	4.3E+06	nm	1.8E+07	nm	3.1E+00	n	1.3E+01	n					
Silver	7440-22-4	3.9E+02	n	5.1E+03	n					7.1E+01	n		6.0E-01	
Simazine	122-34-9	4.1E+00	c*	1.4E+01	c					5.2E-01	c	4.0E+00	2.6E-04	2.0E-03
Sodium Acifluorfen	62476-59-9	7.9E+02	n	8.0E+03	n					2.0E+02	n		1.6E+00	
Sodium Azide	26628-22-8	3.1E+02	n	4.1E+03	n					6.2E+01	n			
Sodium Diethyldithiocarbamate	148-18-5	1.8E+00	c	6.4E+00	c					2.5E-01	c			
Sodium Fluoride	7681-49-4	3.9E+03	n	5.1E+04	n	1.4E+01	n	5.7E+01	n	7.8E+02	n			
Sodium Fluoroacetate	62-74-8	1.2E+00	n	1.2E+01	n					3.1E-01	n		6.3E-05	
Sodium Metavanadate	13718-26-8	7.8E+01	n	1.0E+03	n					1.6E+01	n			
Stirofos (Tetrachlorovinphos)	961-11-5	2.0E+01	c*	7.2E+01	c					2.4E+00	c		7.0E-03	
Strontium, Stable	7440-24-6	4.7E+04	n	6.1E+05	nm					9.3E+03	n		3.3E+02	
Strychnine	57-24-9	1.8E+01	n	1.8E+02	n					4.6E+00	n		5.1E-02	
Styrene	100-42-5	6.3E+03	ns	3.6E+04	ns	1.0E+03	n	4.4E+03	n	1.1E+03	n	1.0E+02	1.2E+00	1.1E-01
Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9	4.9E+01	n	4.9E+02	n					1.3E+01	n		7.4E-02	
Sulfuric Acid	7664-93-9	1.4E+06	nm	6.0E+06	nm	1.0E+00	n	4.4E+00	n					
Systhane	88671-89-0	1.5E+03	n	1.5E+04	n					3.5E+02	n		4.3E+00	
TCMTB	21564-17-0	1.8E+03	n	1.8E+04	n					3.7E+02	n		2.6E+00	
Tebuthiuron	34014-18-1	4.3E+03	n	4.3E+04	n					1.1E+03	n		3.0E-01	
Temephos	3383-96-8	1.2E+03	n	1.2E+04	n					3.1E+02	n		6.0E+01	
Terbacil	5902-51-2	7.9E+02	n	8.0E+03	n					2.0E+02	n		5.9E-02	
Terbufos	13071-79-9	1.5E+00	n	1.5E+01	n					1.8E-01	n		3.9E-04	
Terbutryn	886-50-0	6.1E+01	n	6.2E+02	n					1.0E+01	n		1.4E-02	
Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1	6.1E+00	n	6.2E+01	n					1.6E+00	n		4.2E-02	
Tetrachlorobenzene, 1,2,4,5-	95-94-3	1.8E+01	n	1.8E+02	n					1.2E+00	n		5.8E-03	
Tetrachloroethane, 1,1,1,2-	630-20-6	1.9E+00	c	9.3E+00	c	3.3E-01	c	1.7E+00	c	5.0E-01	c		1.9E-04	
Tetrachloroethane, 1,1,2,2-	79-34-5	5.6E-01	c	2.8E+00	c	4.2E-02	c	2.1E-01	c	6.6E-02	c		2.6E-05	
Tetrachloroethylene	127-18-4	5.5E-01	c	2.6E+00	c	4.1E-01	c	2.1E+00	c	7.2E-02	c	5.0E+00	3.3E-05	2.3E-03
Tetrachlorophenol, 2,3,4,6-	58-90-2	1.8E+03	n	1.8E+04	n					1.7E+02	n		1.1E+00	
Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	2.4E-02	c	8.6E-02	c					3.4E-03	c		1.1E-05	
Tetraethyl Dithiopyrophosphate	3689-24-5	3.1E+01	n	3.1E+02	n					5.3E+00	n		3.9E-03	
Tetrafluoroethane, 1,1,1,2-	811-97-2	1.1E+05	nms	4.6E+05	nms	8.3E+04	n	3.5E+05	n	1.7E+05	n		9.3E+01	
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	2.4E+02	n	2.5E+03	n					6.3E+01	n		5.9E-01	
Thallium (Soluble Salts)	7440-28-0	7.8E-01	n	1.0E+01	n					1.6E-01	n	2.0E+00	1.1E-02	1.4E-01
Thiobencarb	28249-77-6	6.1E+02	n	6.2E+03	n					1.2E+02	n		4.2E-01	
Thiodiglycol	111-48-8	5.4E+03	n	6.8E+04	n					1.1E+03	n		2.2E-01	
Thiofanox	39196-18-4	1.8E+01	n	1.8E+02	n					4.1E+00	n		1.4E-03	
Thiophanate, Methyl	23564-05-8	4.9E+03	n	4.9E+04	n					1.2E+03	n		1.1E+00	
Thiram	137-26-8	3.1E+02	n	3.1E+03	n					7.6E+01	n		1.1E-01	
Tin	7440-31-5	4.7E+04	n	6.1E+05	nm					9.3E+03	n		2.3E+03	
Titanium Tetrachloride	7550-45-0	1.4E+05	nm	6.0E+05	nm	1.0E-01	n	4.4E-01	n					
Toluene	108-88-3	5.0E+03	ns	4.5E+04	ns	5.2E+03	n	2.2E+04	n	8.6E+02	n	1.0E+03	5.9E-01	6.9E-01
Toluene-2,5-diamine	95-70-5	2.7E+00	c**	9.6E+00	c**					3.7E-01	c**		1.2E-04	
Toluidine, p-	106-49-0	2.6E+00	c	9.1E+00	c					3.4E-01	c		1.4E-04	
Toxaphene	8001-35-2	4.4E-01	c	1.6E+00	c	7.6E-03	c	3.8E-02	c	1.3E-02	c	3.0E+00	2.1E-03	4.6E-01
Tralomethrin	66841-25-6	4.6E+02	n	4.6E+03	n					1.2E+02	n		4.5E+01	
Tri-n-butyltin	688-73-3	1.8E+01	n	1.8E+02	n					4.7E+00	n		1.0E-01	
Triallate	2303-17-5	7.9E+02	n	8.0E+03	n					8.7E+01	n		1.9E-01	

Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	MCL-based SSL (mg/kg)
Triasulfuron	82097-50-5	6.1E+02	n	6.2E+03	n					1.6E+02	n		1.6E-01	
Tribromobenzene, 1,2,4-	615-54-3	3.1E+02	n	3.1E+03	n					7.8E+01	n		1.1E-01	
Tributyl Phosphate	126-73-8	5.4E+01	c*	1.9E+02	c*					4.5E+00	c*		2.2E-02	
Tributyltin Compounds	NA	1.8E+01	n	1.8E+02	n					4.7E+00	n			
Tributyltin Oxide	56-35-9	1.8E+01	n	1.8E+02	n					4.4E+00	n		2.3E+02	
Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1	4.3E+04	ns	1.8E+05	nms	3.1E+04	n	1.3E+05	n	5.3E+04	n		1.3E+02	
Trichloroacetic Acid	76-03-9	6.9E+00	c	2.5E+01	c					9.4E-01	c	6.0E+01	1.9E-04	1.2E-02
Trichloroaniline HCl, 2,4,6-	33663-50-2	1.7E+01	c	5.9E+01	c					2.3E+00	c		6.4E-03	
Trichloroaniline, 2,4,6-	634-93-5	1.8E+00	n	1.8E+01	n					3.0E-01	n		2.7E-03	
Trichlorobenzene, 1,2,3-	87-61-6	4.9E+01	n	4.9E+02	ns					5.2E+00	n		1.5E-02	
Trichlorobenzene, 1,2,4-	120-82-1	2.2E+01	c**	9.9E+01	c**	2.1E+00	n	8.8E+00	n	9.9E-01	c**	7.0E+01	2.9E-03	2.0E-01
Trichloroethane, 1,1,1-	71-55-6	8.7E+03	ns	3.8E+04	ns	5.2E+03	n	2.2E+04	n	7.5E+03	n	2.0E+02	2.6E+00	7.0E-02
Trichloroethane, 1,1,2-	79-00-5	1.1E+00	c**	5.3E+00	c**	1.5E-01	c**	7.7E-01	c**	2.4E-01	c**	5.0E+00	7.7E-05	1.6E-03
Trichloroethylene	79-01-6	9.1E-01	c**	6.4E+00	c**	4.3E-01	c**	3.0E+00	c**	4.4E-01	c**	5.0E+00	1.6E-04	1.8E-03
Trichlorofluoromethane	75-69-4	7.9E+02	n	3.4E+03	ns	7.3E+02	n	3.1E+03	n	1.1E+03	n		6.9E-01	
Trichlorophenol, 2,4,5-	95-95-4	6.1E+03	n	6.2E+04	n					8.9E+02	n		3.3E+00	
Trichlorophenol, 2,4,6-	88-06-2	4.4E+01	c**	1.6E+02	c**	7.8E-01	c	4.0E+00	c	3.5E+00	c**		1.3E-02	
Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5	6.1E+02	n	6.2E+03	n					1.2E+02	n		5.2E-02	
Trichlorophenoxypropionic acid, -2,4,5	93-72-1	4.9E+02	n	4.9E+03	n					8.4E+01	n	5.0E+01	4.6E-02	2.8E-02
Trichloropropane, 1,1,2-	598-77-6	3.9E+02	n	5.1E+03	ns					7.8E+01	n		3.1E-02	
Trichloropropane, 1,2,3-	96-18-4	5.0E-03	c	9.5E-02	c	3.1E-01	n	1.3E+00	n	6.5E-04	c		2.8E-07	
Trichloropropene, 1,2,3-	96-19-5	7.8E-01	n	3.3E+00	n	3.1E-01	n	1.3E+00	n	6.2E-01	n		3.1E-04	
Tridiphane	58138-08-2	1.8E+02	n	1.8E+03	n					4.7E+01	n		3.3E-01	
Triethylamine	121-44-8	1.2E+02	n	5.2E+02	n	7.3E+00	n	3.1E+01	n	1.5E+01	n		4.4E-03	
Trifluralin	1582-09-8	6.3E+01	c**	2.2E+02	c*					2.2E+00	c*		7.2E-02	
Trimethyl Phosphate	512-56-1	2.4E+01	c*	8.6E+01	c*					3.4E+00	c*		7.4E-04	
Trimethylbenzene, 1,2,3-	526-73-8	5.3E+01	n	2.2E+02	n	5.2E+00	n	2.2E+01	n	1.0E+01	n		1.5E-02	
Trimethylbenzene, 1,2,4-	95-63-6	6.2E+01	n	2.6E+02	ns	7.3E+00	n	3.1E+01	n	1.5E+01	n		2.1E-02	
Trimethylbenzene, 1,3,5-	108-67-8	7.8E+02	ns	1.0E+04	ns					8.7E+01	n		1.2E-01	
Trinitrobenzene, 1,3,5-	99-35-4	2.2E+03	n	2.7E+04	n					4.6E+02	n		1.7E+00	
Trinitrotoluene, 2,4,6-	118-96-7	1.9E+01	c**	7.9E+01	c**					2.2E+00	c**		1.3E-02	
Triphenylphosphine Oxide	791-28-6	1.2E+03	n	1.2E+04	n					2.8E+02	n		1.2E+00	
Tris(2-chloroethyl)phosphate	115-96-8	2.4E+01	c*	8.6E+01	c*					3.3E+00	c*		3.2E-03	
Tris(2-ethylhexyl)phosphate	78-42-2	1.5E+02	c*	5.4E+02	c					2.1E+01	c*		1.0E+02	
Uranium (Soluble Salts)	NA	2.3E+02	n	3.1E+03	n	3.1E-01	n	1.3E+00	n	4.7E+01	n	3.0E+01	2.1E+01	1.4E+01
Urethane	51-79-6	1.2E-01	c	1.7E+00	c	3.3E-03	c	4.2E-02	c	2.1E-02	c		4.8E-06	
Vanadium Pentoxide	1314-62-1	4.0E+02	c**	2.0E+03	c**	2.9E-04	c*	1.5E-03	c*	1.1E+02	n			
Vanadium and Compounds	NA	3.9E+02	n	5.2E+03	n					7.8E+01	n		7.8E+01	
Vernolate	1929-77-7	6.1E+01	n	6.2E+02	n					8.3E+00	n		6.6E-03	
Vinclozolin	50471-44-8	1.5E+03	n	1.5E+04	n					3.4E+02	n		2.6E-01	
Vinyl Acetate	108-05-4	9.7E+02	n	4.1E+03	ns	2.1E+02	n	8.8E+02	n	4.1E+02	n		8.7E-02	
Vinyl Bromide	593-60-2	1.1E-01	c*s	5.6E-01	c*s	7.6E-02	c*	3.8E-01	c*	1.5E-01	c*		4.4E-05	
Vinyl Chloride	75-01-4	6.0E-02	c	1.7E+00	c	1.6E-01	c	2.8E+00	c	1.5E-02	c	2.0E+00	5.3E-06	6.9E-04
Warfarin	81-81-2	1.8E+01	n	1.8E+02	n					4.4E+00	n		4.6E-03	
Xylene, P-	106-42-3	6.0E+02	ns	2.6E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.8E-01	
Xylene, m-	108-38-3	5.9E+02	ns	2.5E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.8E-01	
Xylene, o-	95-47-6	6.9E+02	ns	3.0E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.9E-01	
Xylenes	1330-20-7	6.3E+02	ns	2.7E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n	1.0E+04	1.9E-01	9.8E+00
Zinc Phosphide	1314-84-7	2.3E+01	n	3.1E+02	n					4.7E+00	n			
Zinc and Compounds	7440-66-6	2.3E+04	n	3.1E+05	nm					4.7E+03	n		2.9E+02	
Zineb	12122-67-7	3.1E+03	n	3.1E+04	n					7.8E+02	n		2.3E+00	

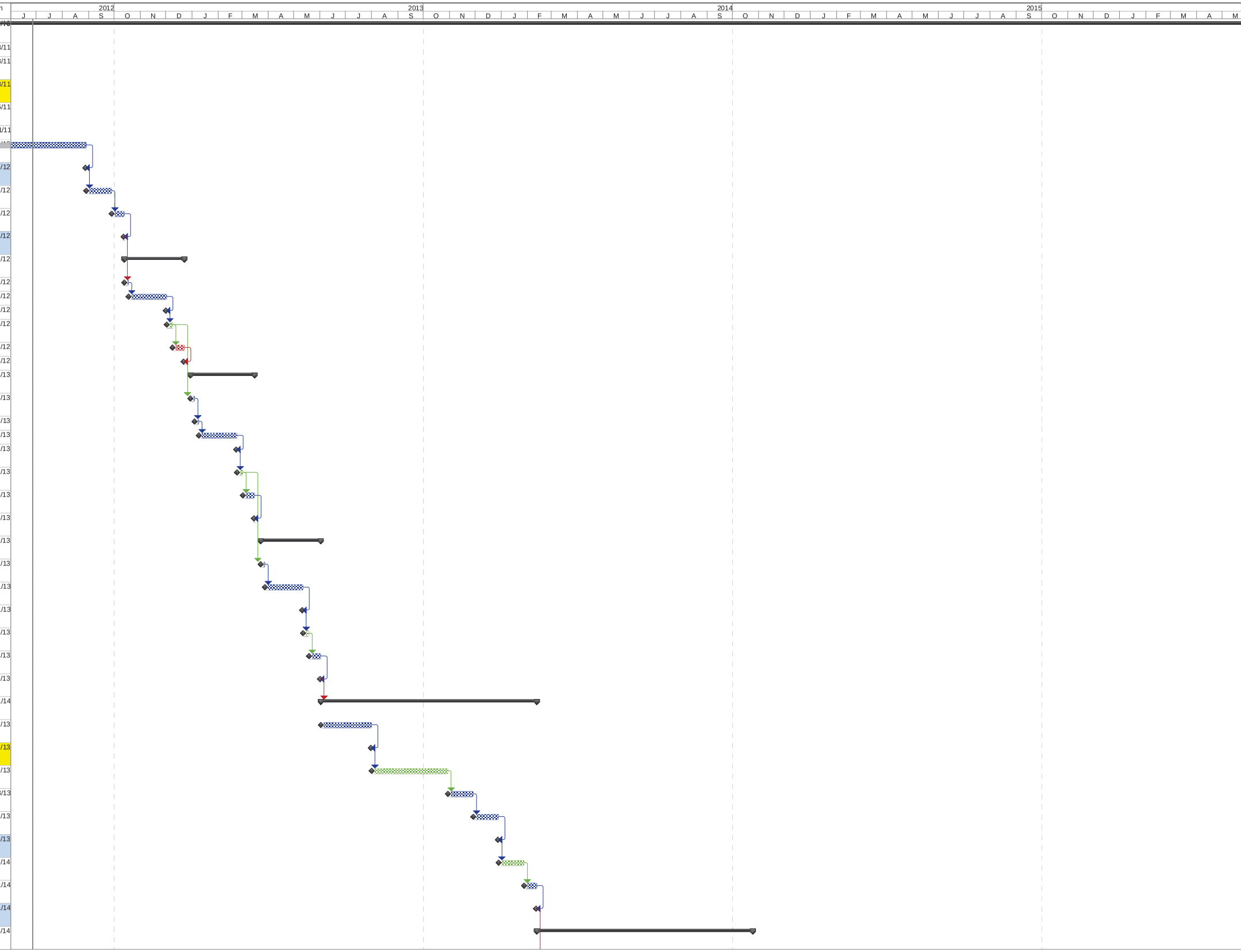
APPENDIX E

GANT MILESTONES SCHEDULE

(Draft Schedule will be revised in NAS Pensacola Site Management Plan)

NAS PENSACOLA
OU 19, Site 44 Feasibility Study Addendum Work Plan (UFP SAP) Schedule
Updated June 27, 2012

ID	Task Name	Duration	Actual Start	Actual Finish
1	~~OU 19/SITE 44- FORMER UST SITE 0227~~	~~2047 days~~	~~Thu 4/28/11~~	~~Sat 12/8/18~~
2	DQO Meeting	1 day	Thu 4/28/11	Thu 4/28/11
3	Prepare Draft Feasibility Study Addendum Work plan	85 days	Thu 5/5/11	Thu 7/28/11
4	Submit Draft Feasibility Study Addendum Work plan to Regulators	1 day	Thu 7/28/11	Thu 7/28/11
5	Regulatory Review/Comment of Draft Feasibility Study Addendum Work plan	90 days	Fri 7/29/11	Wed 10/26/11
6	Response to Regulator Comments	6 days	Thu 10/27/11	Tue 11/1/11
7	Prepare Draft Final Feasibility Study Addendum Work plan	221 days	Wed 11/2/11	Tue 6/26/12
8	Submit Draft Final Feasibility Study Addendum Work plan	1 day	Tue 8/28/12	Tue 8/28/12
9	Approval Draft Final Feasibility Study Addendum Work plan	30 days	Wed 8/29/12	Thu 9/27/12
10	Prepare Final Feasibility Study Addendum Work plan	15 days	Fri 9/28/12	Fri 10/12/12
11	Submit Final Feasibility Study Addendum Work plan and Final HASP	1 day	Fri 10/12/12	Fri 10/12/12
12	Event One	71 days	Sat 10/13/12	Sat 12/22/12
13	1st Event GW Sampling Event	5 days	Sat 10/13/12	Wed 10/17/12
14	Prepare Draft 1st Event Tech Memo	45 days	Thu 10/18/12	Sat 12/1/12
15	Submit Draft 1st Event Tech Memo	1 day	Sat 12/1/12	Sat 12/1/12
16	Regulatory Review/Comment Resolution Telecon	7 days	Sun 12/2/12	Sat 12/8/12
17	Prepare Final 1st Event Tech Memo	14 days	Sun 12/9/12	Sat 12/22/12
18	Submit Final 1st Even Tech Memo	1 day	Sat 12/22/12	Sat 12/22/12
19	Event Two	76 days	Sun 12/30/12	Fri 3/15/13
20		5 days	Sun 12/30/12	Thu 1/3/13
21	2nd Event GW Sampling Event	5 days	Fri 1/4/13	Tue 1/8/13
22	Prepare Draft 2nd Event Tech Memo	45 days	Wed 1/9/13	Fri 2/22/13
23	Submit Draft 2nd Event Tech Memo	1 day	Fri 2/22/13	Fri 2/22/13
24	Regulatory Review/Comment Resolution Telecon	7 days	Sat 2/23/13	Fri 3/1/13
25	Prepare Final 2nd Event Tech Memo	14 days	Sat 3/2/13	Fri 3/15/13
26	Submit Final 2nd Event Tech Memo	1 day	Fri 3/15/13	Fri 3/15/13
27	Event Three	71 days	Sat 3/23/13	Sat 6/1/13
28	3rd Event GW Sampling Event	5 days	Sat 3/23/13	Wed 3/27/13
29	Prepare Draft 3rd Event Tech Memo	45 days	Thu 3/28/13	Sat 5/11/13
30	Submit Draft 3rd Event Tech Memo	1 day	Sat 5/11/13	Sat 5/11/13
31	Regulatory Review/Comment Resolution Telecon	7 days	Sun 5/12/13	Sat 5/18/13
32	Prepare Final 3rd Event Tech Memo	14 days	Sun 5/19/13	Sat 6/1/13
33	Submit Final 3rd Event Tech Memo	1 day	Sat 6/1/13	Sat 6/1/13
34	Feasibility Study	255 days	Sun 6/2/13	Tue 2/11/14
35	Prepare Draft Feasibility Study Addendum	60 days	Sun 6/2/13	Wed 7/31/13
36	Submit Draft Feasibility Study Addendum	1 day	Wed 7/31/13	Wed 7/31/13
37	Regulatory Review	90 days	Thu 8/1/13	Tue 10/29/13
38	Response to Comments	30 days	Wed 10/30/13	Thu 11/28/13
39	Prepare Draft Final Feasibility Study Addendum	30 days	Fri 11/29/13	Sat 12/28/13
40	Submit Draft Final Feasibility Study Addendum	1 day	Sat 12/28/13	Sat 12/28/13
41	Regulatory Review/Comment Resolution	30 days	Sun 12/29/13	Mon 1/27/14
42	Prepare Final Feasibility Study Addendum	15 days	Tue 1/28/14	Tue 2/11/14
43	Submit Final Feasibility Study Addendum	1 day	Tue 2/11/14	Tue 2/11/14
44	Proposed Plan	255 days	Wed 2/12/14	Fri 10/24/14



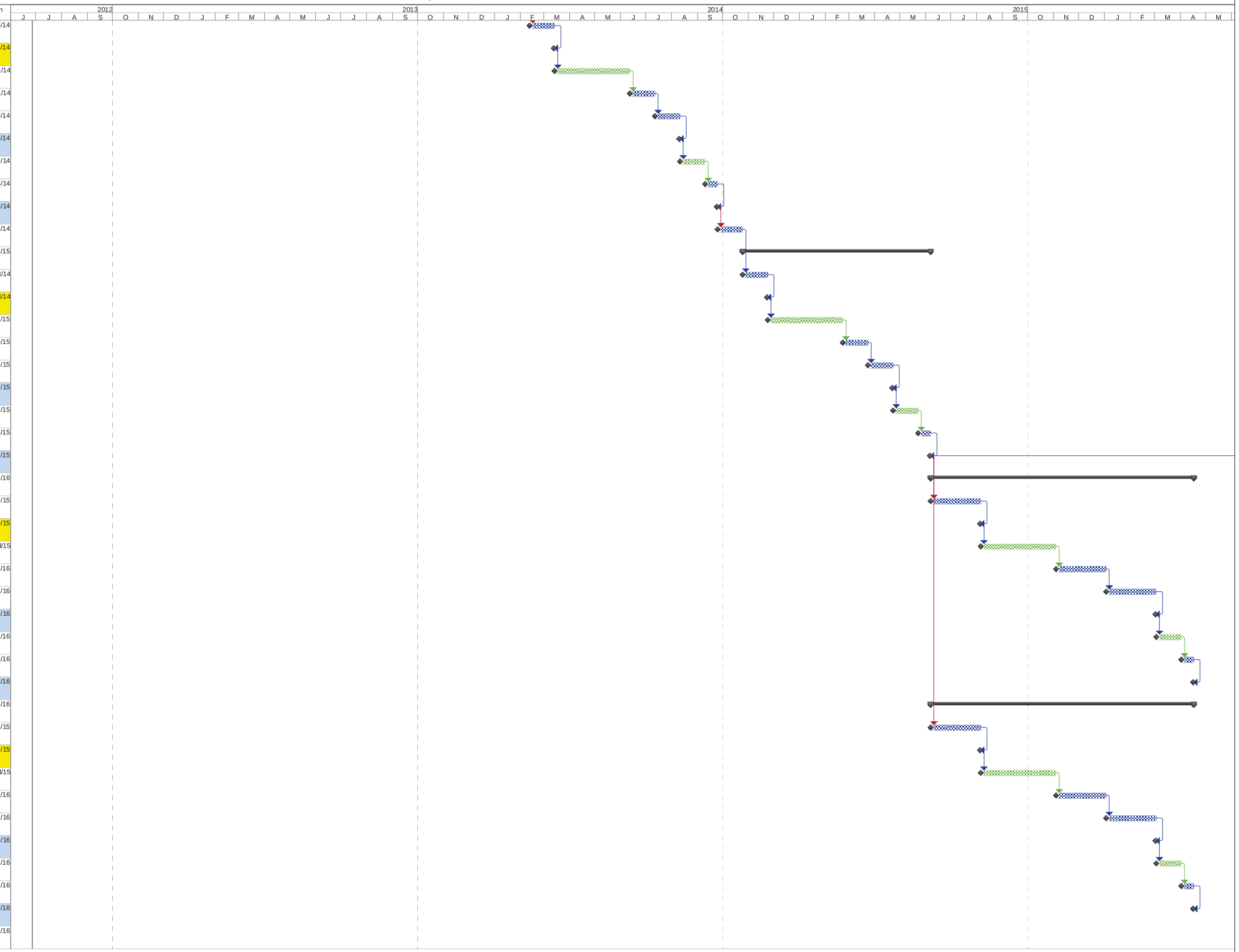
Blue block- Navy
Green block- Regulators
Red block- Approval

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

Yellow/Aqua Highlighted Cell= Primary Deliverable

NAS PENSACOLA
OU 19, Site 44 Feasibility Study Addendum Work Plan (UFP SAP) Schedule
Updated June 27, 2012

ID	Task Name	Duration	Actual Start	Actual Finish
45	Prepare Draft Proposed Plan	30 days	Wed 2/12/14	Thu 3/13/14
46	Submit Draft Proposed Plan	1 day	Thu 3/13/14	Thu 3/13/14
47	Regulatory Review	90 days	Fri 3/14/14	Wed 6/11/14
48	Response to Comments	30 days	Thu 6/12/14	Fri 7/11/14
49	Prepare Draft Final Proposed Plan	30 days	Sat 7/12/14	Sun 8/10/14
50	Submit Draft Final Proposed Plan	1 day	Sun 8/10/14	Sun 8/10/14
51	Regulatory Review/ Comment Resolution	30 days	Mon 8/11/14	Tue 9/9/14
52	Prepare Final Proposed Plan	15 days	Wed 9/10/14	Wed 9/24/14
53	Submit Final Proposed Plan	1 day	Wed 9/24/14	Wed 9/24/14
54	Public Comment	30 days	Thu 9/25/14	Fri 10/24/14
55	Record of Decision	225 days	Sat 10/25/14	Sat 6/6/15
56	Prepare Draft ROD	30 days	Sat 10/25/14	Sun 11/23/14
57	Submit Draft ROD	1 day	Sun 11/23/14	Sun 11/23/14
58	Regulatory Review	90 days	Mon 11/24/14	Sat 2/21/15
59	Response to Comments	30 days	Sun 2/22/15	Mon 3/23/15
60	Prepare Draft Final ROD	30 days	Tue 3/24/15	Wed 4/22/15
61	Submit Draft Final ROD	1 day	Wed 4/22/15	Wed 4/22/15
62	Regulatory Review/ Comment Resolution	30 days	Thu 4/23/15	Fri 5/22/15
63	Prepare Final Proposed ROD	15 days	Sat 5/23/15	Sat 6/6/15
64	Submit Final ROD	1 day	Sat 6/6/15	Sat 6/6/15
65	Remedial Design	315 days	Sun 6/7/15	Sat 4/16/16
66	Prepare Draft Remedial Design	60 days	Sun 6/7/15	Wed 8/5/15
67	Submit Draft Remedial Design	1 day	Wed 8/5/15	Wed 8/5/15
68	Regulatory Review	90 days	Thu 8/6/15	Tue 11/3/15
69	Response to Comments	60 days	Wed 11/4/15	Sat 1/2/16
70	Prepare Draft Final Remedial Design	60 days	Sun 1/3/16	Wed 3/2/16
71	Submit Draft Final Remedial Design	1 day	Wed 3/2/16	Wed 3/2/16
72	Regulatory Review/ Comment Resolution	30 days	Thu 3/3/16	Fri 4/1/16
73	Prepare Final Remedial Design	15 days	Sat 4/2/16	Sat 4/16/16
74	Submit Final Remedial Design	1 day	Sat 4/16/16	Sat 4/16/16
75	Land Use Control	315 days	Sun 6/7/15	Sat 4/16/16
76	Prepare Draft LUC	60 days	Sun 6/7/15	Wed 8/5/15
77	Submit Draft LUC	1 day	Wed 8/5/15	Wed 8/5/15
78	Regulatory Review	90 days	Thu 8/6/15	Tue 11/3/15
79	Response to Comments	60 days	Wed 11/4/15	Sat 1/2/16
80	Prepare Draft Final LUC	60 days	Sun 1/3/16	Wed 3/2/16
81	Submit Draft Final LUC	1 day	Wed 3/2/16	Wed 3/2/16
82	Regulatory Review/ Comment Resolution	30 days	Thu 3/3/16	Fri 4/1/16
83	Prepare Final LUC	15 days	Sat 4/2/16	Sat 4/16/16
84	Submit Final LUC	1 day	Sat 4/16/16	Sat 4/16/16
85	Remedial Action Complete	1 day	Sat 12/3/16	Sat 12/3/16



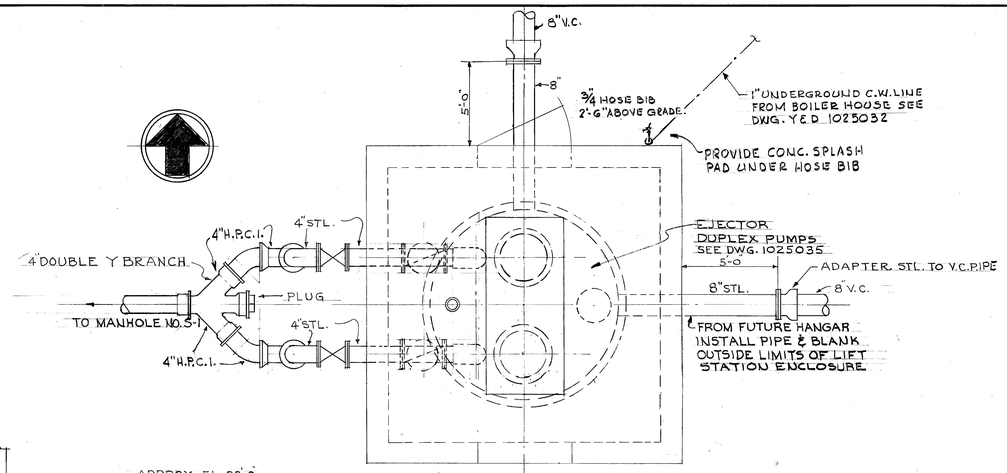
Blue block- Navy
Green block- Regulators
Red block- Approval

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

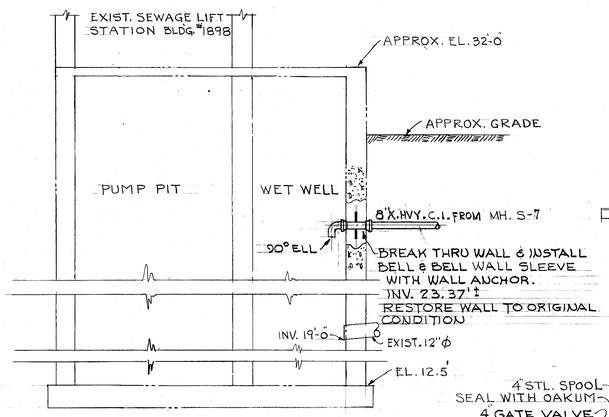
Yellow/Aqua Highlighted Cell= Primary Deliverable

APPENDIX F

RECORD DRAWINGS FOR THE SANITARY SEWER SYSTEM

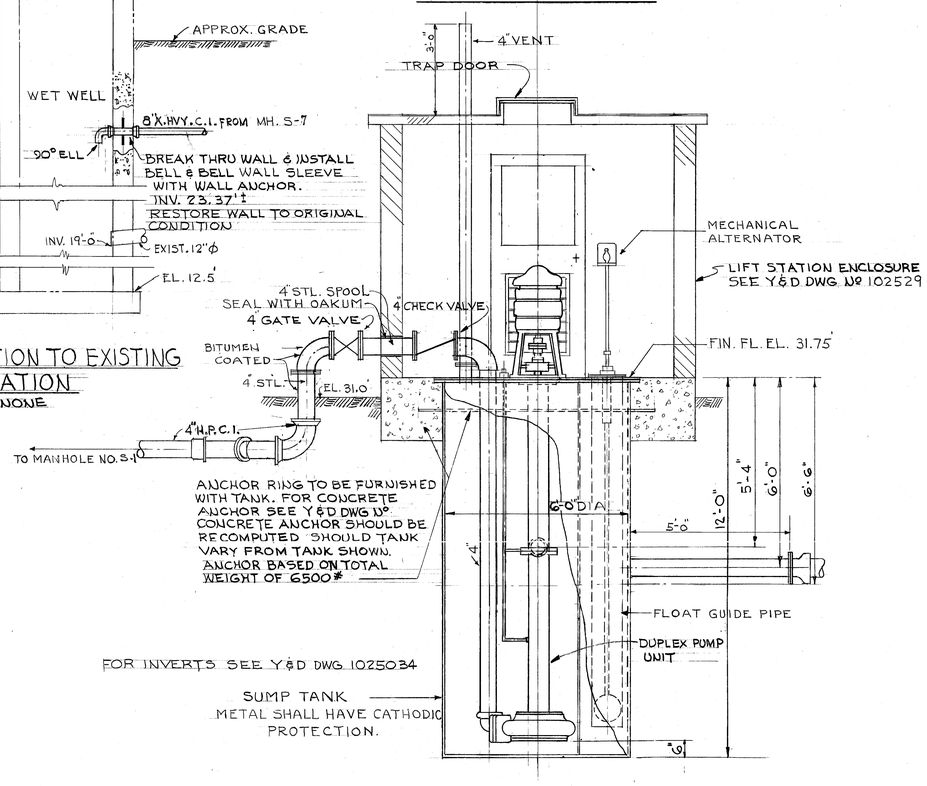


LIFT STATION PLAN



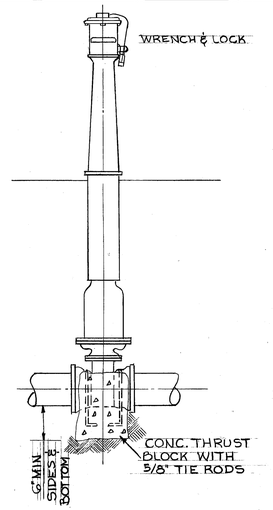
DETAIL CONNECTION TO EXISTING LIFT STATION

SCALE: NONE



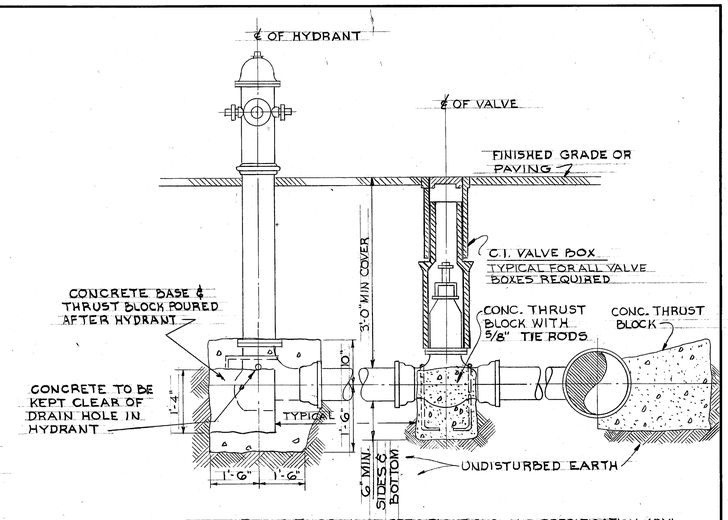
SECTION THRU LIFT STATION

SCALE: 1/2" = 1'-0"



TYPICAL POST INDICATOR VALVE

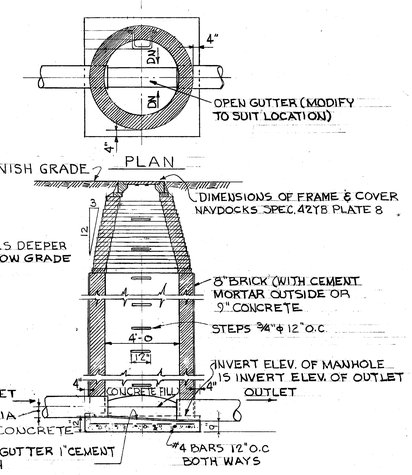
SCALE: NONE



NOTE: REFER TO PROJECT SPECIFICATIONS AND SPECIFICATION 42Y6 FOR ADDITIONAL DETAILS

TYPICAL FIRE HYDRANT & VALVE INSTALLATION

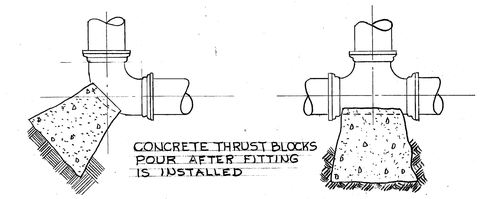
SCALE = NONE



SECTION

SANITARY SEWER MANHOLE

SCALE: NONE



NOTE: REFER TO PROJECT SPECIFICATIONS AND SPECIFICATION 42Y6 FOR ADDITIONAL DETAILS CONCRETE DIMENSIONS SHALL BE BASED ON 4000 PSF SOIL PRESSURE

TYPICAL CONCRETE THRUST BLOCKS

SCALE: NONE

GRAPHIC SCALES

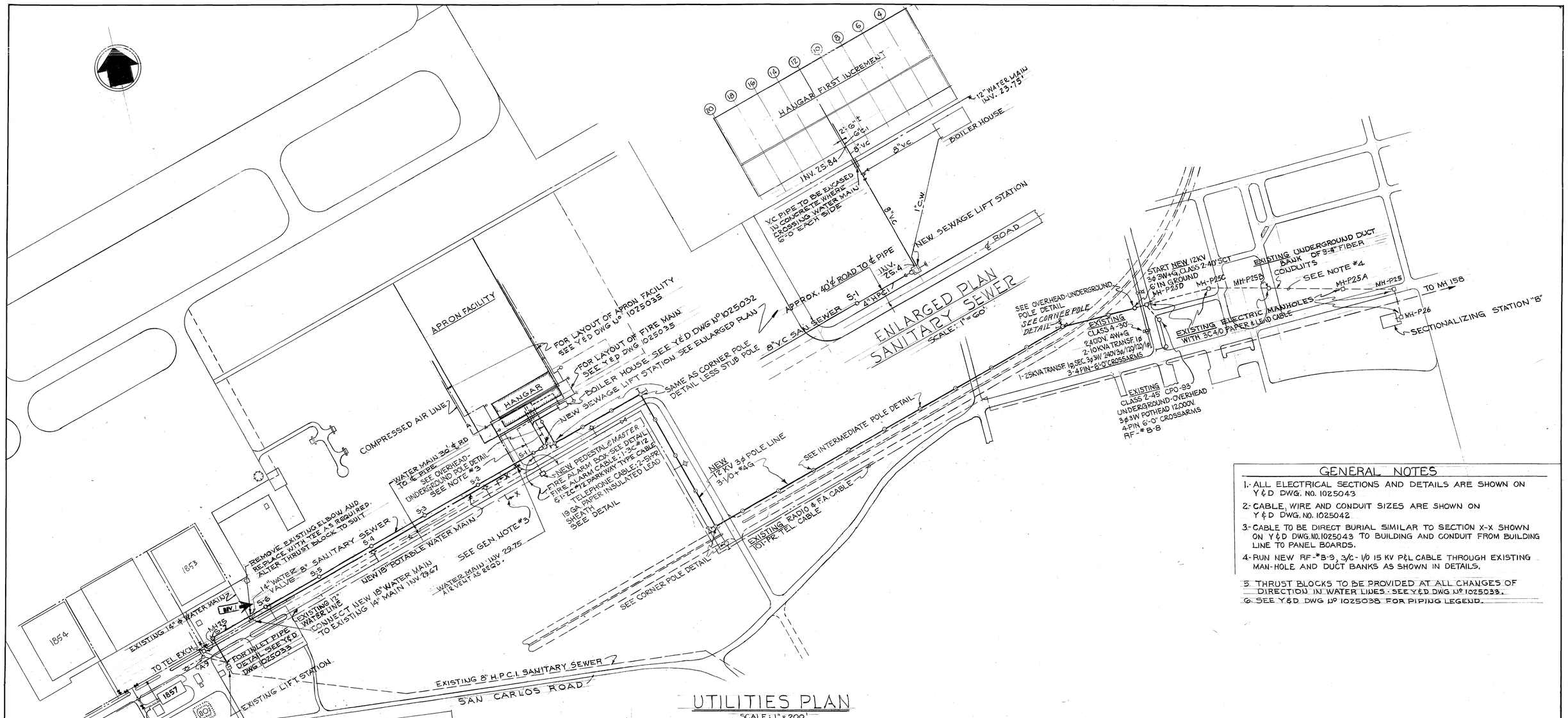
SCALE 1/2" = 1'-0" 0 1 5 10

RECORD DRAWING
DATE 14 SEP 1966

AS-BUILT DRWG. NO CORRECTIONS

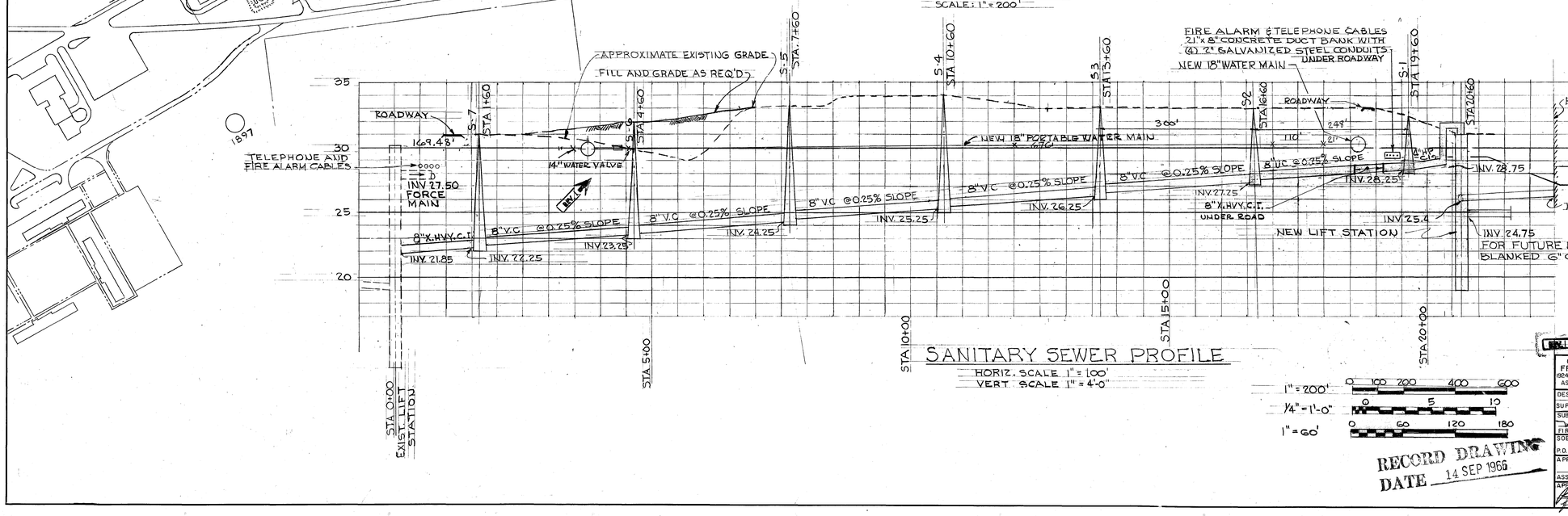
GREEN & WALL, INC. FRANK J. SINDELAR, A.I.A. 1604 N. PALAFOX STR. PENSACOLA, FLA. ASSOCIATED ARCHITECT-ENGINEER	DEPARTMENT OF THE NAVY SOUTHEAST DIVISION - BUREAU OF YARDS AND DOCKS U.S. NAVAL BASE CHARLESTON, S.C.
DES. J. Gaubert DR. J. Gaubert CHK. R. Parker SUPV. R. Parker CH. ENGR. R. Parker SUBMITTED BY: R. F. Reim DATE 10/7/64 FIRM MEMBER	U.S. NAVAL AIR STATION PENSACOLA, FLA. AIRCRAFT REWORK HANGAR SEWAGE STATION & UTILITY DETAILS
SOEASTDOCKS-ENGINEERING DIVISION P.D.E. RICHBOURG DIR. Richbourg	
APPROVED DATE ASST. DIRECTOR FOR DESIGN	CODE IDENT. NO. / SIZE / Y&D DRAWING NO. 1025033
APPROVED FOR BUDOCKS DATE 10/27/64 DIRECTOR FOR CHIEF OF BUREAU	SCALE AS NOTED / SPEC. 48879/62 / NBy 48879 / SHEET 24 OF 36

66



UTILITIES PLAN

SCALE: 1" = 200'



SANITARY SEWER PROFILE

HORIZ. SCALE 1" = 100'
VERT. SCALE 1" = 4'-0"

1" = 200' 0 100 200 400 600
1/4" = 1'-0" 0 5 10
1" = 60' 0 60 120 180

GENERAL NOTES

1. ALL ELECTRICAL SECTIONS AND DETAILS ARE SHOWN ON Y&D DWG. NO. 1025043
2. CABLE, WIRE AND CONDUIT SIZES ARE SHOWN ON Y&D DWG. NO. 1025042
3. CABLE TO BE DIRECT BURIAL SIMILAR TO SECTION X-X SHOWN ON Y&D DWG. NO. 1025043 TO BUILDING AND CONDUIT FROM BUILDING LINE TO PANEL BOARDS.
4. RUN NEW RF-#8-9, 3/C-1/0 15 KV P&L CABLE THROUGH EXISTING MAN-HOLE AND DUCT BANKS AS SHOWN IN DETAILS.
5. THRUST BLOCKS TO BE PROVIDED AT ALL CHANGES OF DIRECTION IN WATER LINES. SEE Y&D DWG Nº 1025033.
6. SEE Y&D DWG Nº 1025038 FOR PIPING LEGEND.

NOTE:

APPROXIMATE EXISTING GRADE TAKEN FROM CONTOURS SHOWN ON Y&D DWG Nº 489860. THESE CONTOURS BASED ON BENCH MARK DESCRIBED AS FOLLOWS. U.S COAST & GEODETIC SURVEY BENCH MARK Nº K9 AT WARRINGTON, ESCAMBIA COUNTY, AT THE NAVY YARD ABOUT 10 YDS. NORTH OF THE CENTER OF THE WEST ENTRANCE IN A BRICK, A STANDARD DISK STAMPED "7.792 K-9 1918 EQUALITY.
US C&GS ELEVATION = 7.792
LOCAL STATION DATUM ELEVATION = 8.00

REV.		
1	AS-BUILT DRAWING - REV. WATER VALVE	7-5-66	S.M.T.

GREEN & WALL, INC
FRANK J. SINDELAR, A.I.A.
1924 N. PALAFOX STR. PENSACOLA, FLA.
ASSOCIATED ARCHITECT - ENGINEER

DEPARTMENT OF THE NAVY
SOUTHEAST DIVISION - BUREAU OF YARDS AND DOCKS
U.S. NAVAL BASE CHARLESTON, S.C.

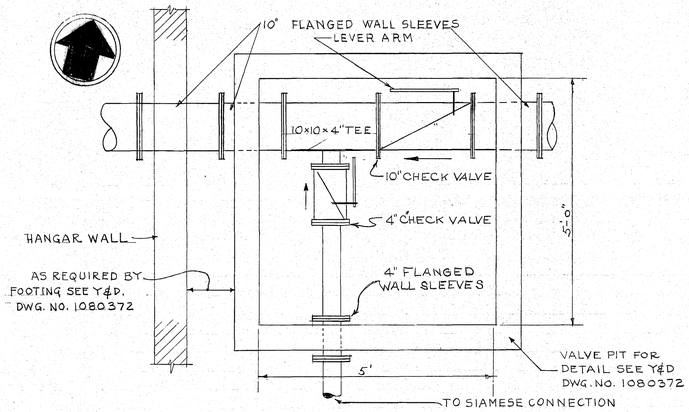
DES. J. Tourtellotte DR. J. Tourtellotte CHK. R. Patterson
SUPV. R. Clemson CH. ENGR. A. Simmons
SUBMITTED BY 10/7/64
FIRM MEMBER
SOEASTDOCKS ENGINEERING DIVISION
P.D.E. RICHBOURG, DIR.
APPROVED DATE
ASST. DIRECTOR FOR DESIGN
APPROVED FOR BUDOCKS DATE 10/7/64
FOR DIRECTOR FOR CHIEF OF BUREAU

U.S. NAVAL AIR STATION
PENSACOLA, FLA.
AIRCRAFT REWORK HANGAR
UTILITY PLAN

CODE IDENT. NO.
SCALE: AS NOTED
SIZE
Y & D DRAWING NO. 1025034
SPEC 48879/62
NBy 48879
SHEET 25 OF 36

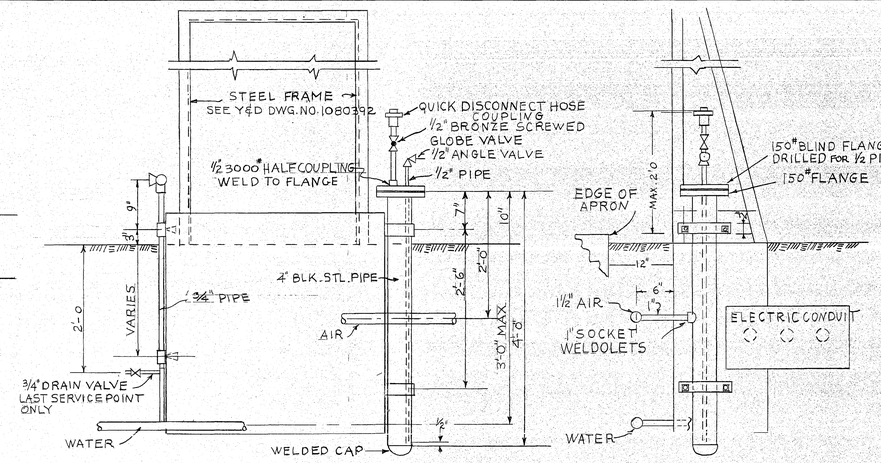
RECORD DRAWING
DATE 14 SEP 1966

66

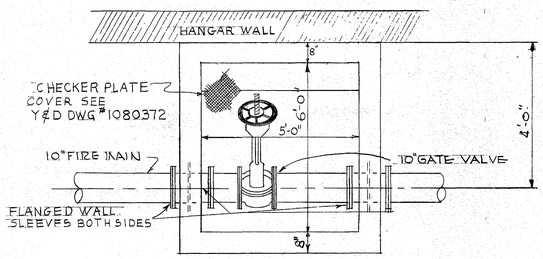


DETAIL OF VALVE PIT

SCALE: 3/4" = 1'-0"

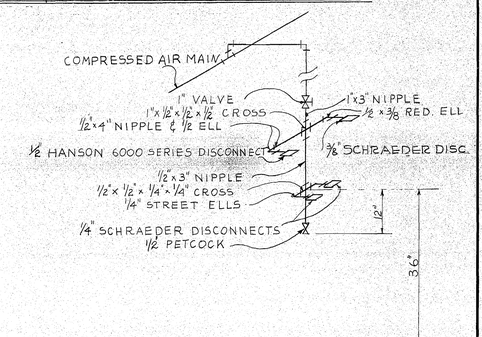


TYPICAL APRON AIR & WATER OUTLET ASSEMBLY



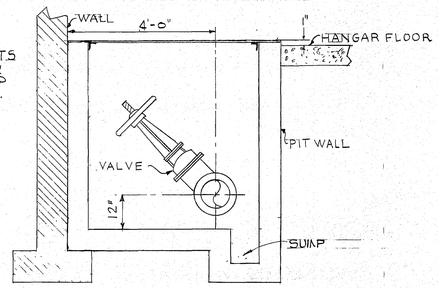
FIRE MAIN VALVE PIT

SCALE: 1/2" = 1'-0"



COMPRESSED AIR SERVICE POINTS

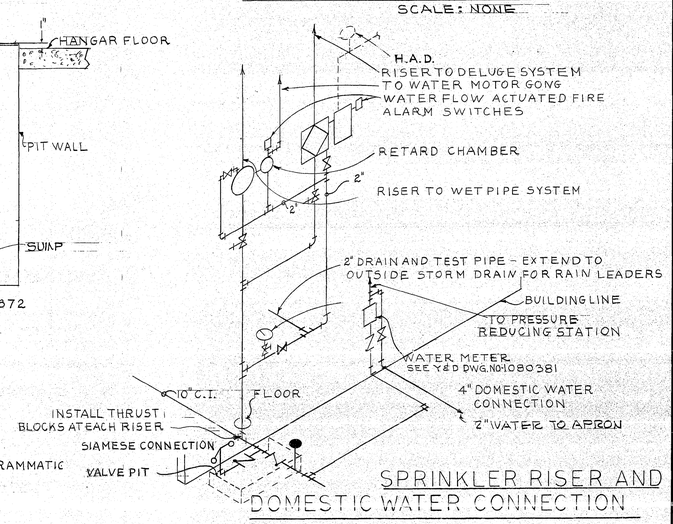
SCALE: NONE



FOR DETAILS SEE Y&D DWG Nº 1080372

SECTION

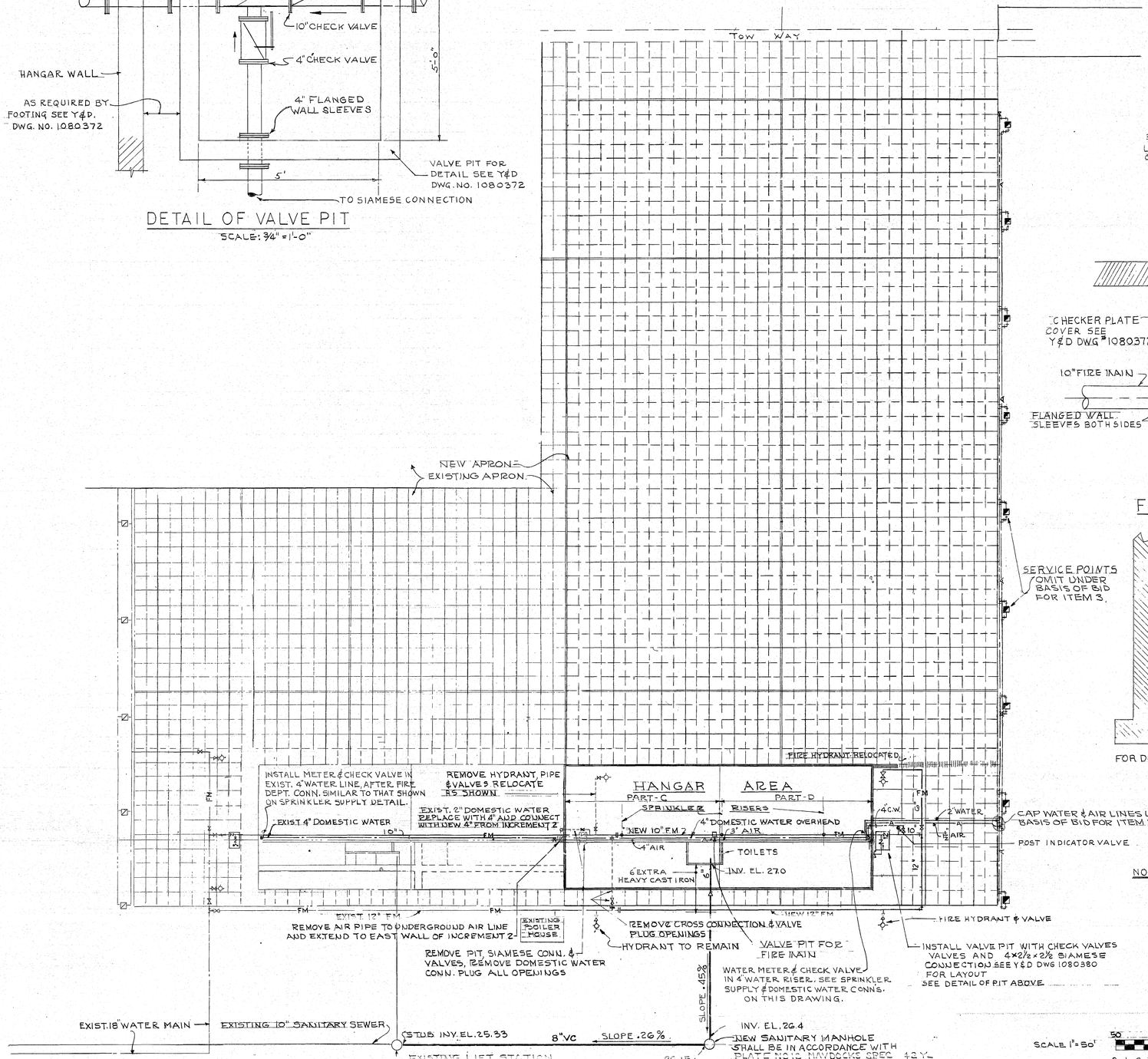
SCALE: 1/2" = 1'-0"



SPRINKLER RISER AND DOMESTIC WATER CONNECTION

NOTE

ALL PIPING ON PLAN IS DIAGRAMMATIC AND SHOULD NOT BE SCALED



PLAN OF MECHANICAL UTILITIES

SCALE: 1" = 50'

GRAPHIC SCALES

SCALE 1" = 50'

1/4" = 1'-0"

1/2" = 1'-0"

3/4" = 1'-0"

RECORD DRAWING
DATE 19 AUG 1968

AS BUILT DRWG. NO CORRECTIONS

GREEN ASSOCIATES, INC. FRANK J. SINDELAR, A.I.A. 1924 N. PALAFOX STR. PENSACOLA, FLA. ASSOCIATED ARCHITECT-ENGINEER	DEPARTMENT OF THE NAVY SOUTHEAST DIVISION - BUREAU OF YARDS AND DOCKS U.S. NAVAL BASE CHARLESTON, S.C.
DES. J. BRADLEY DR. H. OBLER CHK. H. OBLER SUPV. CH. ENGR. SUBMITTED BY DATE 3/12/65	U.S. NAVAL AIR STATION PENSACOLA, FLA. AIRCRAFT REWORK HANGAR (2ND INCREMENT)
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APPENDIX G

RESPONSES TO USEPA AND FDEP COMMENTS

RESPONSE TO EPA COMMENTS
OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

The following provides the Navy's revised responses to U.S. Environmental Protection Agency (EPA) Region 4 Comments dated September 23, 2011 on the Uniform Federal Policy (UFP) Sampling and Analysis Plan (SAP) (Field Sampling Plan and Quality Assurance Project Plan), Groundwater Monitoring Work Plan for OU 19 (Site 44) Feasibility Study Addendum DRAFT dated July 2011. The draft responses submitted by the Navy on November 1, 2011 have been revised based on discussions and resolution of EPA's follow on comments (provided by EPA between December 20, 2011 and January 30, 2012) which are included as Attachment 1. Revisions primarily include changes to clarify and cross reference work plan worksheet and figure numbers between the "Tier II" UFP-SAP included in the draft work plan and the agency accepted UFP-SAP format that will be included in the revised work plan. Similarly, for clarity, attachment numbers in the draft response to comments were revised to reference the follow on comments provided by the EPA and other information that support the responses contained herein. The attachments for this document include:

Attachment 1: EPA Follow on Comments
Attachment 2: Potentiometric Surface Maps from the 2008 Site 44 Remedial Investigation
Attachment 3: Field Modification Form
Attachment 4: Sewer System in the Vicinity of Building 3221
Attachment 5: Aerial Photograph Review
Attachment 6: Figure 5-1 from The Initial Assessment Study
Attachment 7: Summary of Groundwater Sampling Events and Analytical Methods
Attachment 8: Comparison of Analytical Methods and Analytes
Attachment 9: Revised Figures

General Comments

1. The Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan), Groundwater Monitoring Work Plan for Operable Unit 19 (Site 44) Feasibility Study Addendum dated July 2011 (Work Plan), for Naval Air Station (NAS) Pensacola is improperly titled, leading to confusion. This effort is not intended to be a groundwater monitoring effort. The intent of this sampling effort is to complete a contaminant nature and extent investigation (that was not completed during the original OU 19 Remedial Investigation) in order to generate OU-19 specific data in support remedial alternatives analysis for source mitigation and groundwater remediation, as needed, to achieve a protective cleanup of OU 19. *Revise the title as follows for clarity and transparency: Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan), Groundwater Investigation Work Plan for Operable Unit 19 (Site 44) dated July 2011 (Work Plan)*. Revise any language in the Work Plan that suggests that this investigation effort is solely to support screening of a Monitored Natural Attenuation remedial alternative.

   EPA agreed with the Navy proposal to include the OU 19 groundwater investigation data and data interpretation in an Addendum to the existing OU 19 Feasibility Study Report (versus an Addendum to the existing Remedial Investigation Report). This agreement is reflected in the appropriate worksheet of the Work Plan.

Response: Comment acknowledged. The word "*Monitoring*" will be replaced with "*Investigation*" in the work plan title. The work plan will be reviewed again for any language that may suggest this investigation effort is solely to support screening of a Monitored Natural Attenuation remedial alternative.

2. The Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan), Groundwater Monitoring Work Plan for Operable Unit 19 (Site 44) Feasibility Study Addendum dated July 2011 (Work Plan), for Naval Air Station (NAS) Pensacola does not provide the specific groundwater sampling procedures necessary for a Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP). Worksheet No. 8, Field Project Implementation (Field Project Instructions), Section 8.1.3, Monitoring Well Sampling, states that all groundwater samples will be

collected using the procedures specified in Florida Department of Environmental Protection (FDEP) Standard Operating Procedure (SOP) FS 2200. However, this SOP covers many different sampling approaches. The Work Plan should specify the type of pump as well as any other equipment that will be used during purging and sampling (e.g., flow-through cell, multi-meter) and clarify whether the equipment will be dedicated or will require decontamination between wells. *Revise the Work Plan text to specifically state how groundwater samples will be collected for the Site 44 groundwater investigation. During the three-party scoping activities, EPA requested that the Low Flow/Low Stress sampling procedure be used.*

Response: Field procedures will follow EPA, Region 4, Science and Ecosystem Support Division (SESD), Athens, Georgia, Field Branches Quality System and Technical Procedures. These procedures contain routine field sampling and measurement procedures, and quality control documents used by field investigators of the SESD Field Branches: the Ecological Assessment Branch and the Enforcement and Investigations Branch. If EPA, Region 4, SESD does not have an applicable field procedure, then Florida Department of Environmental Protection (FDEP) Standard Operating Procedures will be used. A new appendix will be created in the UFP-SAP for the EPA Field Branches Quality System and Technical Procedures.

The referenced text, formerly in Worksheet 8 and now in Worksheet 14, will be revised to state that groundwater field parameters: dissolved oxygen, temperature, oxidation reduction potential, pH and turbidity will be used to evaluate the aquifer and to determine when groundwater is representative of site conditions. Measurement of field parameters will be made using a multi-meter (to be selected at the time of the sampling event) and flow-through cells. Field equipment calibration procedures will be conducted as per manufacturer's instructions and EPA, Region 4, Science and Ecosystem Support Division (SESD), Athens, Georgia, Field Branches Quality System and Technical Procedures.

The referenced text, formerly in Worksheet 8 and now in Worksheet 14, will be revised to state that groundwater samples will be collected in accordance with EPA, Region 4, SESD, Athens, Georgia, Field Branches Quality System and Technical Procedures. The text will also state that groundwater samples will be collected using a peristaltic pump and low flow/low stress sampling techniques. Following purging the monitoring well and the collection of samples of metals analysis, the tubing will be withdrawn and the groundwater sample for VOC analyses will be collected directly from the tubing that was inserted into the monitoring well using the straw or reverse flow method. Decontamination of the peristaltic pump and tubing will not be required because new Teflon® and silicon tubing will be used for each monitoring well.

The decision rule for the first round of sampling requires further clarification in the fourth paragraph of Worksheet No. 5, Data Quality Objectives/Systematic Planning Process Statements, Section 5.1, Problem Statement, Page 43 of 89. The text states "If groundwater concentrations measured in the most downgradient well do not exceed Project Action Limits (PALs) or indicate the plume has migrated, no further investigation of the shallow groundwater plume in the downgradient direction is recommended." This statement implies that further investigation will hinge upon the results of only one well, which may be problematic if the downgradient boundary is widespread and monitored by several wells. Additionally, it is unclear how it will be determined whether the plume has migrated if no additional wells are installed downgradient of the existing plume boundary. Worksheet No. 4, Conceptual Site Model, Figure 4-4, Summary of Groundwater Trichloroethylene Results from the CAR (1993) and RI (2008), indicates that TCE was detected in well PEN-44-24 above the Florida cleanup target level (CTL). No wells are located further north of this location in the downgradient direction and installation of additional shallow wells in this direction is not currently proposed. Based on the current decision rule, if groundwater concentrations measured in well PEN-44-24 do not exceed PALs during the next sampling event, no further investigation will be necessary. However, this approach will not determine whether groundwater contamination previously identified in this well has already migrated beyond the currently defined network of wells. In our scoping meetings, we discussed the need for additional wells and agreed that the Navy would

recommend the location(s) for EPA and FDEP evaluation after the data are available from the first round of groundwater sampling. For example, based on the information summarized above, the Navy should consider installing an additional shallow well north of well PEN-44-24 to better evaluate plume migration and/or plume stability.

> *Revise the Work Plan to clarify the decision rule for determining whether additional investigation (i.e., installation of additional wells) downgradient of the currently defined plume boundaries is necessary. The decision rule should be reworded to state "If the first of the three (minimum) to four rounds of sampling indicates that the plume has moved downgradient, changed shape, or concentrations have increased, additional wells will be installed to better evaluate plume migration and/or stability."*

Response: The referenced decision rule formerly in Worksheet No. 5 and now in Worksheet 11, Section 11.1 Problem Statement will be clarified to read:

"The dynamic sampling design and related installation of four new monitoring well clusters are described in Worksheet No. 17 (formerly Worksheet No. 7) for the three quarterly sampling events covered by this work plan.

The decision rule that is applicable to the first of a minimum of three rounds of data collection as agreed to by EPA, FDEP and the Navy during the Data Quality Objective meeting is as follows:

If the Project Team's evaluation of the data from the first quarterly sampling event indicates the plume has migrated beyond the limits of the existing monitoring wells, the Team will determine the location of additional wells to be installed to better evaluate plume migration and/or stability, and proceed accordingly with the provisions described under Groundwater Sampling in Worksheet No. 17. Otherwise, the Project Team will proceed in accordance with well installation and other provisions described under Groundwater Sampling in Worksheet No. 17."

3. The Work Plan proposes to screen soil and groundwater using AQR Color-Tec® field screening techniques. However, sufficient details on the purpose of this screening as well as SOPs for this screening technique have not been provided. *For clarity, revise the Work Plan to provide further description of the AQR Color-Tec® technology, clarify its purpose, and include sufficiently detailed field procedures for use of this screening technique to ensure this technique is appropriate for screening soil and groundwater at Site 44.*

Response: The text in Worksheet 17 (formerly Worksheet 7) will be amended to state the following; "The purpose of the field screening techniques, OVA and AQR Color-Tec® techniques, will be used to determine monitoring well total depths and screen intervals for newly the installed monitoring wells. This will be accomplished by field screening of soil samples from the low permeability layers and layers containing peat or other organic material to assess the potential these layers may have sorbed higher concentrations of contaminants that could result in long-term back diffusion of PCE, TCE, cis-DCE, and VC."

The AQR Color-Tec® method will be described in the text. This method uses a hand operated vacuum pump to purge volatile compounds from soil samples through colorimetric gas detector tubes. The tubes are designed to produce a distinct color change when exposed to all chlorinated volatile organic halocarbons (CVOHs), including saturated and unsaturated chlorinated alkenes and alkanes. This field screening method will only be used to determine the presence of CVOHs on a qualitative basis and not used to yield quantitative data for comparison against regulatory screening levels. The text will also be amended to indicate that the AQR Color-Tec® method will be conducted in accordance with EPA's Standard Operating Procedures (SOPs) for Analysis of Total Chlorinated Ethenes in Soil and Groundwater Using the Color Tec Screening Method and AQR Color-Tec® Method Procedures Manual. A new appendix will be created in the UFP-SAP for

the EPA Field Branches Quality System and Technical Procedures which will include the EPA AQR Color-Tec® SOP. The AQR Color-Tec® Method Procedures Manual will also be included in an appendix of the UFP-SAP.

4. The Work Plan states that groundwater at Site 44 flows from southwest to northeast (Worksheet No. 4, Conceptual Site Model, Section 4.2.1, Contamination Assessment Report, and Section 4.2.2, Remedial Investigation Report). However, potentiometric surface maps have not been provided as supporting documentation. Further, Section 4.3.3, Migration Pathways and Potential Receptors, also states in the last sentence on Page 33 of 89, "Based on the uniformity of groundwater elevation isocontours, groundwater infiltration to the storm sewer does not appear to be occurring." *To support the conceptual site model (CSM), revise the Work Plan to include a potentiometric surface map using groundwater elevation data from the most recent round of monitoring. If sufficient data are not available to support a potentiometric surface map, the CSM should so state and capture both groundwater flow direction and the occurrence of groundwater infiltration as uncertainties that need to be addressed through the groundwater investigation. Navy should evaluate the DQOs (and revise the Work Plan as needed) to ensure that sufficient data will be collected to address these uncertainties.*

   In addition, the enumeration of the section header for Section 4.2.1 and Section 4.2.2 should be corrected since the section prior to these two sections is entitled Section 4.2.1, UST Removal Actions.

Response: Appendix A of the UFP-SAP contains potentiometric surface maps for the investigations conducted prior to the Site 44 RI (2008), but potentiometric surface maps prepared for the Site 44 RI (2008) were inadvertently omitted in the UFP-SAP. To provide additional data to support the CSM, the potentiometric maps (See Attachment 2) prepared for the Site 44 RI (2008) will be added to Appendix A in the UFP-SAP. The potentiometric surface maps prepared for the Site 44 RI (2008) support the interpretation that groundwater infiltration to the storm sewer does not appear to be occurring. Also, in Worksheet #7 (now Worksheet #17) it was stated that: "To monitor the potential for groundwater to infiltrate storm sewers, the storm water drains at Site 44 will be visually inspected to determine if water is present and visibly flowing during periods of no rainfall." This statement will be added to Worksheet 14 (formerly Worksheet #8) in paragraph 14.1.5 Water Level Measurements.

The NAS Pensacola Superfund Site is assigned an EPA identification number that should be used on all documents and correspondence relating to work under the Federal Facility Agreement: U.S. EPA ID FL9170024567. *Revise the OU 19 Work Plan to reflect the EPA ID number on the cover and title pages, in the Executive Summary in a paragraph that identifies this facility as a Superfund site, and in the appropriate QAPP Work Sheet. Future records generated to satisfy the Navy's CERCLA cleanup requirements for NAS Pensacola must include the EPA ID Number for purposes of creating and maintaining a transparent Administrative Record.*

Response: As requested, the U.S. EPA ID FL9170024567 will be included on the cover and title pages, in the Executive Summary in a paragraph that identifies this facility as a Superfund site, and in the appropriate QAPP Work Sheet. In addition, the Navy will ensure the EPA ID number is included in future NAS Pensacola CERCLA documents and correspondence relating to work under the Federal Facility Agreement.

Specific Comments

1. Worksheet No. 2, Communication Pathways, Page 13 of 89

The table in Worksheet No. 2 indicates that the Procedure for Work Plan amendments (under the Communication Drivers column header) will include completion of a Field Task Modification Request (FTMR) form to document proposed changes. The FTMR form does not appear to have been included with this Work Plan. *For completeness, revise the Work Plan to provide all referenced forms including the FTMR form.*

Response: The Field Task Modification Request (FTMR) form, which is provided in Attachment 3, will be included in Appendix B.

2. Worksheet No. 4, Conceptual Site Model, Section 4.1, Site Background, Page 23 of 89

It appears there may be a discrepancy associated with the sequence of dates described for use of Building 3221. The first paragraph of Worksheet No. 4, Section 4.1 states that in 1983, Building 3221 was part of the Naval Air Rework Facility (NARF). The paragraph further states that the building was likely used for aircraft maintenance before the current National Museum of Naval Aviation location opened in 1975. It is unclear how the National Museum of Naval Aviation (the current use of Building 3221) could have opened at a date prior to 1983 when the building was reportedly part of NARF. *Revise the Work Plan to clarify the timeframes in which Building 3221 was used by NARF and by the National Museum of Naval Aviation.*

Response: In reviewing the entire first paragraph in Section 4.1 (now Section 10.1) there does not appear to be a discrepancy in the sequence of dates for use of Building 3221:

"Site 44 is located at the southwest end of Building 3221, which is currently used by the National Museum of Naval Aviation staff to refurbish aircraft used for display. Building 3221 is a large hangar adjacent to Forrest Sherman Field, which was opened in 1955 as the master jet landing field for NAS Pensacola (Figure 4-1 [now Figure 10-1). In 1983, Building 3221 was shown as part of the Naval Air Rework Facility (NARF), formerly the NAS Pensacola operations and repair department [Naval Energy and Environmental Support Activity (NEESA), 1983] and was likely used for aircraft maintenance before the current National Museum of Naval Aviation location opened in 1975."

However, the following paragraph will be added to Section 10.1: "The National Museum of Naval Aviation, which opened in 1975, is located on Radford Blvd. several hundred feet south of Building 3221 and is not located in Building 3221. Building 3221, which has also been referred to as the Aircraft Maintenance and Restoration Facility, is currently used by staff from the National Museum of Naval Aviation to refurbish aircraft used for museum display."

3. Worksheet No. 4, Conceptual Site Model, Section 4.1, Site Background, Page 23 of 89

The second paragraph of Worksheet No.4, Section 4.1 indicates that the past and current use of the paved area adjacent to the southwest corner of Building 3221 is a wash rack for cleaning aircraft and aircraft parts. It is further noted that "only biodegradable surfactant agents are used by the National Museum of Naval Aviation to clean parts." However, the Work Plan does not describe what chemicals may have been used prior to the activities associated with the National Museum of Naval Aviation. *Revise the Work Plan to describe the historical processes and any chemicals that may have been used (used, stored, disposed, released, or may have migrated) at*

the site prior to activities associated with the National Museum of Aviation. Addition of this information to the CSM may help identify potential sources and/or chemicals of potential concern.

Response: The following paragraph will be added to Section 10.1 (formerly Section 4.1): "As stated in the RI, according to National Museum of Naval Aviation personnel only Simple Green (a biodegradable surfactant agent) is used by the National Museum of Naval Aviation to clean parts (TtNUS, 2007). However, as stated in the response to Comment No. 8, limited information is available about the historical maintenance operations or chemicals that may have been used in Building 3221 or the adjacent wash rack area (Site 44). Presumably surfactants and to a lesser extent some solvents, e.g., PD-680 and perhaps TCE, were used in the wash rack area to clean aircraft and aircraft parts. PD-680 was stored in the 1000-gallon UST installed at the site in 1967 and removed in 1989-1990. PD-680 solvent, commonly called Stoddard Solvent or mineral spirits, contains petroleum fractions which are complex mixtures of mostly aliphatic hydrocarbons, but which may contain some aromatics and olefinics. According to Federal Specifications for PD-680 and related DOD literature, PD-680 was historically used for dry cleaning and for general cleaning to remove oil and grease from aircraft and engine components and from ground support equipment. Cold solvent cleaning generally takes the form of either spray sinks or batch loaded dip tanks. Limited amounts of chlorinated solvents, e.g., TCE, may also have been used in the wash rack area to clean aircraft and aircraft parts."

4. <u>Worksheet No. 4 – Conceptual Site Model, Section 4.1, Site Background, Page 23 of 89</u>

The third paragraph of Worksheet No. 4, Section 4.1 describes surface drainage at the site. It is also noted that a diverter system, in operation during aircraft washing activities, has been installed that directs run-off to the sanitary sewer system. The locations of the underground sanitary sewer piping has not been described or depicted on a site figure. Additionally, the age and construction of the piping has not been described. *Revise the Work Plan to provide further details on any subsurface structures at the site, including sanitary sewer piping as it may be acting as a preferential pathway for contaminant migration.*

Response: Drawings (Attachment 4) prepared for the construction of the additional area to the east side of Building 3221 indicates that a new lift station was constructed approximately 200 feet southeast of the southeast corner of Building 3221. Connections to the lift station include the diverter system which is located approximately 300 feet to the west-northwest of the lift station; a connection to the original Building 3221 that runs approximately 200 feet to the northwest of the southwest side of the building; and a connection to the new addition to Building 3221 that runs approximately 300 feet to the northeast then turns 90 degrees to the northwest and runs 200 feet to the southeast side of the new addition to Building 3221. The drawing indicates that the pipes are 8-inch diameter or smaller and the material used for construction was not provided. The lift station has an invert of approximately 28.75 feet (the land surface is shown to be approximately 31.5 feet) and connects to an existing 8-inch diameter sanitary sewer that has a slope of approximately 0.25%. The existing sanitary sewer pipe runs to the southeast for approximately 1,880 feet where it connects to a lift station with an invert at approximately 21.85 feet (the land surface is shown to be approximately 31 feet). Based on potentiometric surface maps prepared for the Site 44 RI (2008), the sewer system is located hydraulically upgradient to the plume at Site 44 and would not be acting as a preferential pathway for contaminant migration.

5. <u>Worksheet No. 4, Conceptual Site Model, Section 4.1, Site Background, Page 23 of 89</u>

The fourth paragraph of Worksheet No. 4, Section 4.1 indicates that the 500-gallon underground storage tank (UST) installed in 1992 was used to store waste oil. The source of the waste oil (e.g., activities that may have generated the waste oil) is not described. The final disposition of the waste oil is also not discussed. *Revise the Work Plan to present further detail on the waste oil UST including how the waste oil was disposed/recycled to ensure that the proposed analytical*

suite addresses the potential waste oil constituents. Also, describe how the waste oil was handled prior to installation of the tank in 1992.

Response: Section 10.1 (formerly Section 4.1) will be revised to provide the requested information. The 500-gallon waste oil UST was installed during the NAS Pensacola tank removal program conducted during 1989-1990 after a 1,000-gallon UST used to store PD-680 (a petroleum distillate cleaning solvent) was removed from the same location. The 500-gallon waste oil UST was removed in 1994 (Navy, 1994). The text in Section 10.1 (formerly Section 4.1) will be revised to indicate the waste oil stored in this UST was likely generated from aircraft maintenance operations historically performed at Building 3221. In general based on historical reports from installation personnel, some of the waste oil stored in waste oil tanks at NAS Pensacola was contaminated with hydraulic fluids, acids, and paint strippers. Historical methods of disposal of waste oil at NAS Pensacola included removal by contractor, disposal through the IWTP, and disposal to the crash crew fire training activity. The disposal method and collection by a contractor for reprocessing and recycling was in place in 1983 during the Initial Assessment Study (NEESA, 1983) prior to the installation of the waste oil tank at Site 44 in 1989-1990. There is no available information on where the waste may have been stored and handled prior to being transported for the crash crew fire training activity. Also see related response to Comment 10 concerning discrepancies about UST sizes and installation and removal dates.

6. <u>Worksheet No. 4, Conceptual Site Model, Section 4.1, Site Background, Page 23 of 89</u>

The last paragraph of Worksheet No. 4, Section 4.1 describes "an asphalt-covered storage area for various aircraft parts" in the northwest portion of the site. Past use of this area is not described. *To facilitate an understanding of potential source areas and associated contaminants, revise the Work Plan to describe both current and past use of the aircraft parts storage area.*

Response: The asphalt-covered storage area is located to the south-southwest of Site 44. Based on the review of aerial photographs from 1961 to 2010 (Attachment 5), which was obtained from the Florida Department of Transportation, the "asphalt paved storage area" to the south-southwest of Site 44 appears to have been used as a "laydown" area for equipment through time. The aerial photographs become too pixilated when enlarged to determine what was temporarily stored at the "asphalt paved storage area".

7. <u>Worksheet No. 4, Conceptual Site Model, Section 4.2.1, Contamination Assessment Report (CAR), Page 24 of 89</u>

In the subsection entitled Soil Assessment of Worksheet No. 4, Section 4.2.1, the text indicates that thirteen subsurface soil samples were analyzed for arsenic, cadmium, chromium, and lead. However, the depth range associated with these samples is not described. *For clarity, revise the Work Plan to summarize the depths at which subsurface soil samples were collected during this previous investigation.*

Response: A detailed summary for the sampling event is provided in Appendix A of the UFP-SAP in Section A1.2.1 Soil Assessment. This section states that: "Discreet soil samples were collected at 5 to 7 feet beneath the land surface (bls) at thirteen of the soil boring locations and at 2 foot intervals to a depth of 6 feet bls at four boring locations. The soil samples were field screened for organic vapors by the headspace method with a flame ionizing detector (FID). Thirteen subsurface soil samples were analyzed for waste oil group metals (arsenic, cadmium, chromium and lead) and one subsurface soil sample was analyzed for TRPH." This information will also be added to Section 10.2.2 (formerly Section 4.2.2) Contamination Assessment Report.

8. Worksheet No. 4, Conceptual Site Model, Section 4.3.2, Potential or Known Sources of Contamination, Page 31 of 89

The second paragraph of Worksheet No. 4, Section 4.3.2 states that Building 3221 was evaluated as a potential historical source of groundwater contamination at Site 44 "because of its past use for aircraft maintenance and because of the former materials staging area previously located in the wash rack area adjacent to Building 3221." Specific aircraft maintenance activities inside Building 3221, potential chemicals associated with these activities, and waste handling practices associated with these activities are not described. Additionally, it is unclear whether any other potential sources may have existed inside Building 3221 that may require further evaluation. Since soil sampling at Building 3221 appears to have been focused west of the building (Appendix A, Summary of Previous Investigations, Appendix A2, Figures, Figure 2-1, Soil Boring Locations), additional discussion should be provided to eliminate other areas of the building as potential source areas. *Revise the Work Plan to describe the specific aircraft maintenance activities conducted inside Building 3221, describe potential chemicals associated with these activities, and describe waste handling practices associated with these activities. Additionally, clarify whether any other potential sources may have existed inside Building 3221.*

Response: The following paragraph will be included in Section 10.3.2 (formerly Section 4.3.2):

"No additional information is available about the specific aircraft maintenance activities conducted inside Building 3221 nor the potential chemicals and waste handling practices associated with these activities. However according to installation personnel, no spills or releases have been reported at Building 3221. The Initial Assessment Study performed in 1983 identified Building 3221 as part of the NARF facilities. This is shown by Figure 5-1 from the Initial Assessment Study (NEESA, 1983), which is provided in Attachment 6. This figure indicates most of the NARF facilities were located on the eastern side of NAS Pensacola near Chevalier Field where more intensive industrial operations occurred. No findings for Building 3221 were identified in the study and the building was not one of the facilities recommended for confirmation study. The only items associated with Building 3221 in the study are two waste oil tanks located in the vicinity of Building 3221 that have since been removed as part of the tank removal program in 1989-1990. This information will be added to Section 10.3.2 Potential or Known Sources of Contamination."

Also, based on the results of site investigations during the CAR and RI at Site 44, including soil and groundwater sampling along the southwest side and northeast corner of Building 3221 as summarized in Section 10.3.2 (formerly Section 4.3.2) and further detailed in Section 10 (formerly Section 4.0) and Appendix A, the source of the Site 44 TCE groundwater plume appears to be due to wash rack activities and is not the result of activities inside Building 3221.

9. Worksheet No. 4, Conceptual Site Model, Figure 4-4, Summary of Groundwater Trichloroethylene Results from the CAR (1993) and RI (2008)

Figure 4-4 of Worksheet No. 4 indicates a small unlabeled building just east of Building 3629, Museum Storage. The current and historical use of this unlabeled building has not been described in the Work Plan. Since this building is located just upgradient of the trichloroethylene (TCE) plume, further information on its use should be provided in order to determine whether it may be a potential source for the groundwater contamination. *Revise the Work Plan to identify the unlabeled building on Figure 4-4 and describe its current and historical use. If it is determined that this building may be a potential source, additional source investigation should be proposed as it does not appear that any samples for volatile organic compound (VOC) analysis were collected at this location during the remedial investigation (RI) (see Appendix A, Summary of Previous Investigations, Appendix A2, Figures, Figure 2-1, Soil Boring Locations Site 44 RI*

Report.) According to Figure 2-1, a sample was collected at this unnamed building (44SB41) but it was only analyzed for polynuclear aromatic hydrocarbons (PAHs).

Response: The following information will be provided in 10.3.2 Potential or Known Sources of Contamination. The small "unlabeled" building east of Building 3629 is not apparent in an aerial photograph taken on October 11, 1993 (Photograph 8 in Attachment 5), but appears in two aerial photographs one taken on February 15, 1997 and the other taken on February 15, 2000 (Photographs 9 and 10 in Attachment 5. The building does not appear in an aerial photograph taken on March 12, 2004 (Photograph 11 in Attachment 5). Based on the a review of the 1993 Contamination Assessment Report (CAR), the small building was not present at the time the assessment activities were conducted and the CAR indicated that Building 3629 was a flammable storage area and a possible source for the chlorinated solvents. The use and material(s) stored of the small building is unknown.

In addition, Building 3629, an open-sided shed, was assigned by NAS Pensacola as part of the assignment of Hangar 3221 to the National Naval Aviation Museum (NNAM) after the Naval Aviation Depot (NADEP) vacated the building. It was then located adjacent to and northwest of the 3221 wash rack (about 60 yards west of Hangar 3221 west wall). The concrete slab that held the structure is still in place. In about 2000, it was moved to its present location immediately adjacent to the west wall of Hangar 3221. Before being moved, this building was used for storage of a few pieces of rolling stock and also held storage lockers for HAZMAT, primarily acetic acid and a corrosion inhibitor (commercial name: "Corrosion Block"). This storage had the approval of NAS Pensacola Safety authorities. Its present use is for the storage of equipment primarily used at the wash rack and some other small rolling stock. No chemicals have been stored in the structure since it was moved.

The un-numbered structure is a portable metal shed mounted on a trailer. It was originally built to store products in support of the Naval Aviation Museum Foundation (our private support organization) air show sales program. During this time, it was located on the 3221 aircraft parking line or adjacent to Building 3695 (NNAM Exhibits Fabrication Building), which is off site from Hangar 3221. Following the Foundation's termination of the air show sales program, the structure has been used by NNAM for storage of line gear (e.g., tie-downs, chocks, etc.) and other dry storage. No chemicals have been stored in this structure.

10. <u>Worksheet No. 4, Conceptual Site Model, Figure 4-6, Conceptual Site Model</u>

Figure 4-6 of Worksheet No. 4 identifies an existing 1,000-gallon UST for waste oil storage and a former 1,000-gallon UST used for petroleum distillate storage removed in 1989-1990. The existing 1,000-gallon UST for waste oil storage is not described elsewhere in the Work Plan. Worksheet No. 4, Section 4.1, Site Background, describes a 500-gallon UST for waste oil, but this UST was removed in 1994. Additionally, Section 4.1 indicates that the 1,000-gallon UST used for petroleum distillate storage was removed in 1992, not 1989-1990 as noted on Figure 4.6. *Revise Figure 4.6 to address these discrepancies and ensure the text describes the specific practices that produced the waste oils.*

Response: Figure 10-6 (formerly Figure 4-6), Sections 10.1 (formerly Section 4.1) and 10.2.1 (formerly Section 4.2.1), and Appendix A1.1 will be revised to address discrepancies (Figure 10-6 is provided in Attachment 9). The 1,000-gallon UST used for petroleum distillate storage was removed during the NAS Pensacola tank removal program conducted during 1989-1990. It was replaced with a 500-gallon UST used to store waste oil likely generated from aircraft maintenance operations historically performed at Building 3221. This second UST was removed on May 2, 1994 (Navy, 2004). There are no USTs remaining at the site.

11. Worksheet No. 5, Data Quality Objectives/Systematic Planning Process Statements, Section 5.1, Problem Statement, Page 43 of 89

The third bulleted item on Page 43 of 89 only cites the State of Florida drinking water standards and groundwater cleanup target levels (GCTLs) and does not consider meeting Federal drinking water standards or the United States Environmental Protection Agency's (EPA's) Regional Screening Levels (RSLs) most recently published in June of 2011 (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm) *For completeness, the Federal drinking water standards and EPA RSLs should also be considered in addressing potential data gaps for groundwater monitoring: revise the Work Plan accordingly*.

Response: Comment acknowledged; the requested change will be made (Worksheet 5 is now Worksheet 11).

12. Worksheet No. 5, Data Quality Objectives/Systematic Planning Process Statements, Section 5.1, Problem Statement, Page 43 of 89

The last paragraph on Page 43 of 89 indicates that new data quality objectives (DQOs) will be developed following the first and second rounds of data collection. The Work Plan does not describe how these DQOs will be documented. *Revise the Work Plan to clarify how the DQOs will be documented. Note that this comment also applies to Worksheet No. 5, Section 5.4, Analytic Approach.*

Response: The text in Section 11.1 (formerly Section 5.1) will be revised to state that: "Following the first and second rounds of data collection, the Project Team must convene (Partnering Team Meeting or Teleconference) to review the newly collected data, develop DQOs, and design a sampling program for the next sampling event to meet project objectives. A Technical Memorandum will be prepared to document the findings of the newly collected data, document the DQOs that were developed and describe the design of the future sampling event."

13. Worksheet No. 5, Data Quality Objectives/Systematic Planning Process Statements, Section 5.2, Data Needs, Page 44 of 89

The second bulleted item in Worksheet No. 5, Section 5.2 indicates that a data need includes sampling "all currently existing shallow wells during the initial sampling event." According to Worksheet No. 7, Sampling Design and Rationale, Table 7-1, Monitoring Wells and Laboratory Analytical Program, existing deep wells PEN-44-18 and PEN-44-19 will also be sampled during the initial sampling event. *Revise Worksheet No. 5, Section 5.2 to incorporate the deep well sampling as a data need.*

Response: Comment acknowledged; the requested change will be made (Worksheet 5 is now Worksheet 11).

14. Worksheet No. 5, Data Quality Objectives/Systematic Planning Process Statements, Section 5.2, Data Needs, Page 44 of 89

The fourth bulleted item in Worksheet No. 5, Section 5.2 indicates that groundwater samples will be analyzed for tetrachloroethylene (PCE), TCE, 1,2-dichloroethylene (DCE), and vinyl chloride (VC). No other VOCs are currently proposed. It is unclear why an expanded suite of VOCs will not be analyzed in consideration of previously detected VOCs at the site and the lapse in time since samples were last collected (2006). Appendix A, Summary of Previous Investigations, Sections A1.2.3 and A2.2 state that toluene, dibromochloromethane, acetone, methylene chloride, chloroform, chloromethane, and 1,1-dichloroethane were previously detected in site

groundwater. *Revise the Work Plan to provide the rationale for limiting the proposed VOC analysis to PCE and its daughter products (in consideration of previously detected VOCs at the site) and the lapse in time since groundwater samples were last collected.*

Response: The following information will be added to Section 10 Conceptual Site Model. Concentrations of toluene, dibromochloromethane, acetone and methylene chloride were detected in groundwater samples collected onsite in the 1992 site investigation activities and described in the Contamination Assessment Report. Toluene was detected at 16 micrograms per liter (µg/L) in two groundwater samples and in the trip blank at 3 µg/L. The detected concentrations are less than its Federal Maximum Contaminant Level (MCL) and Florida Groundwater Cleanup Target Level (GCTL) of 1,000 µg/L. The detection of toluene was attributed in the Contamination Assessment Report to cross contamination from the labels on the sample bottles. Additionally, toluene was not detected in subsequent sampling events. Dibromochloromethane was detected at 1 µg/L in one groundwater sample and exceeded its Florida GCTL of 0.4 µg/L, but not the Federal MCL and the Florida GCTL of 80 µg/L for total trihalomethane. Dibromochloromethane has not been detected in subsequent sampling events. Acetone was detected at 13 µg/L in an equipment blank and did not exceed its Florida GCTL of 6,300 µg/L. Acetone was not detected in a groundwater sample. Methylene chloride was detected in four groundwater samples and a duplicate at concentrations ranging from 13 to 79 µg/L and in the equipment (13 µg/L), trip (14 µg/L) and laboratory (8 µg/L) blanks. Methylene chloride exceeded its Federal MCL and Florida GCTL of 5 µg/L. Acetone and methylene chloride are common laboratory artifacts and have not been detected in subsequent sampling events.

Concentrations of chloroform, chloromethane, and 1,1-dichloroethane were detected in Site 44 groundwater samples that were collected in 2005 and 2006 for the RI (2008); but were at concentrations below their Federal and State regulatory criteria. However, TCE was detected at concentrations exceeding its GCTL of 3 µg/L in groundwater samples collected from six shallow monitoring wells. The highest detected concentration was in the vicinity of monitoring well PEN-3221-09 (52 µg/L), which was installed as part of the UST investigation and previously had TCE exceedances. TCE was also detected in groundwater samples from monitoring wells PEN-44-11, PEN-44-14, PEN-44-15, PEN-44-21, PEN-44-22 and PEN-44-24. The TCE concentrations in these monitoring wells ranged from 5 to 34 µg/L. Based on these results, a TCE plume appears to extend north to northeast from the washrack area between Buildings 3629 and 3221. TCE was not detected during the RI in groundwater samples from three shallow monitoring wells (PEN-3221-06, PEN-3221-08, and PEN3221-10) located adjacent to the western side of Building 3221 or PEN-3221-17 located adjacent to the north side of Building 3221. This suggests that Building 3221 is not a source of the TCE plume at Site 44.

Groundwater chemicals of concern (COCs) were established for Site 44 based on the human health risk assessment that employs both EPA guidelines and the State of Florida methodology for risk characterization. The RI, Feasibility Study and Proposed Plan identified TCE, bis(2-ethylhexyl)phthalate, iron and manganese as the COCs in groundwater at Site 44. Concentrations of TCE exceed the EPA MCL and Florida GCTL and were retained as a COC. Bis(2-ethylhexyl)phthalate (BEHP) was detected in two groundwater samples at concentrations greater than its GCTL of 6 µg/L. However, these two monitoring wells were resampled on May 9, 2006; the BEHP results were less than the laboratory detection limit (5.2 µg/L) and the GCTL, therefore, BEHP was not retained as a COC. The human health risk assessment in the RI also identified iron and manganese as potential COCs because their maximum concentrations exceeded EPA Secondary MCLs. However, the aquifer is not used as a water supply source in the Pensacola area because of high mineralization. In addition, the Hazard Quotients (HQs) for iron and manganese calculated in the EPA evaluation were less than the EPA and FDEP goal of 1.0 for non-carcinogenic health effects. The maximum detected concentrations of the two metals were also less than the NAS Pensacola background concentrations. Therefore, iron and manganese were not retained as COCs.

Based on the above, the analysis was originally proposed in the draft UFP-SAP to be for VOCs and limited to PCE and its daughter products. However, based on additional comments by the EPA (please refer to Attachment 1, pages 5 through 7 of 8, Worksheet No. 11 (formerly Worksheet No. 5) and Worksheets 17 and 18 (formerly Worksheet No. 7) will be revised to include groundwater samples to be collected for analysis of TCL/TAL analytes from a specific subset of monitoring wells as listed in EPA's email dated January 30, 2012. The basis for EPA's request for TCL/TAL analysis at select wells is because the USEPA CPL TAL/TCL list of analytes has been updated since full scan sampling was performed at the site during the RI in 2005 and there are constituents that may not have been sampled at the site. Likewise, TCL/TAL analyses will be conducted for groundwater samples collected from the new intermediate depth monitoring wells that are proposed to be installed under the current UFP-SAP, because they will be screened in zones of the aquifer not previously sampled. This last paragraph will be added to Section 11 Data Needs.

15. Worksheet No. 5, Data Quality Objectives/Systematic Planning Process Statements, Section 5.5, Performance Criteria, Page 46 of 89

    Worksheet No. 5, Section 5.5 indicates that PALs include GCTLs per Florida Chapter 62-777, F.A.C., Table I, Florida Maximum Contaminant Levels (MCLs) per Chapter 62-550, F.A.C., and EPA Federal MCLs (EPA, 2011). However there is no mention of EPA's RSLs for tap water. *Revise the Work Plan to include EPA RSLs for tap water as potential PALs and ensure EPA RSLs and drinking water criteria are included in subsequent worksheets.*

Response: Comment acknowledged; the requested change will be made.

16. Worksheet No. 7, Sampling Design and Rationale, Page 49 of 89

    The second paragraph on Page 49 of 89 describes groundwater sample collection using a Hydro-Punch® sampler. The Work Plan indicates that the borings will be advanced with a Rotosonic drill rig to collect groundwater samples using this sampler "from five-foot intervals measured from the water table to the blue Marine clay confining layer." *The text does not indicate that the sampling tool will be decontaminated between the different sampling intervals. It would not be appropriate to collect a subsequent groundwater sample if the sampling tool was not decontaminated between sampling events. Revise the Work Plan to address this concern.*

Response: Specific guidance for decontamination of downhole multilevel groundwater samplers is not provided in the EPA Region 4, SESD, Athens, Georgia, Field Branches Quality System and Technical Procedures. However, guidance is provided in EPA's guidance document entitled Groundwater Sampling and Monitoring with Direct Push Technologies, obtained from the EPA Office of Solid Waste and Emergency Response, Washington, DC 20460, (OSWER No. 9200.1-51 EPA 540/R-04/005, August, 2005). This guidance states: "Multi-level samplers, most of which are exposed-screen samplers, are DPT equipment capable of collecting groundwater samples at multiple intervals as the sampling tool is advanced, without having to withdraw the tool for sample collection or decontamination." Furthermore, the document states: "As with all groundwater sampling equipment, DPT equipment should be decontaminated before sampling at a new location to avoid cross contamination." Therefore, the text in Section 14.1.3 Monitoring Well Installation and Development will be revised to indicate that the Hydro-Punch® sampler will be decontaminated between each boring in accordance with EPA guidance.

17. Worksheet No. 7, Sampling Design and Rationale, Table 7-1, Monitoring Wells and Laboratory Analytical Program, Page 51 of 89

    Table 7-1 of Worksheet No. 7 summarizes the proposed analyses for each well in the monitoring program. However, only select wells will be analyzed for natural attenuation (NA) parameters.

The text of the Work Plan does not address the rationale for sampling only some wells and not others for NA parameters. Revise the text of Worksheet No. 7 to describe the rationale for sampling for NA parameters at select wells only.

Response: Table 7-1 is now Worksheet 18. The following text will be inserted in Worksheet No. 11.2 Data Needs to clarify the rationale for sampling for NA parameters at only select wells:

"NA parameters will be collected at only select wells during the first sampling event to establish the footprint of redox conditions along the centerline and edges of the plume to assess the favorability of redox conditions along and downgradient of the plume for complete sequential reductive dechlorination, or other biological or abiotic degradation. During the first sampling event, NA parameters will be sampled at all existing centerline plume wells where redox conditions may be expected to change with distance along the plume. In addition, representative wells have been selected for sampling of NA parameters upgradient, sidegradient, and downgradient of the plume to provide sufficient information to determine the redox conditions in those areas that may be unaffected by plume COCs. As part of optimizing the monitoring plan for subsequent sampling events, the Project Team will determine the location of wells to be sampled in future events for NA parameters, as well as COCs, based on their evaluation of results from the first sampling event."

18. Worksheet No. 8, Field Project Implementation (Field Project Instructions), Page 54 of 89

Worksheet No. 8 does not address the field screening procedures to be used during boring installation [e.g., flame ionization detector (FID) screening and the AQR Color-Tec® screening]. *Field project instructions that are sufficiently detailed for these screening procedures should be included in Worksheet No. 8. Revise Worksheet No. 8 to address FID screening and the AQR Color-Tec® screening, including SOPs as appropriate.*

Response: Worksheet No. 8, Field Project Implementation (Field Project Instructions) is now Worksheet 14, Summary of Field Project Task. The text in Section 14.1.2 Soil Sampling, will be amended to indicate that OVA readings shall be obtained from soil samples at the site using an organic vapor analysis instrument with a flame ionization detector (FID) in the survey mode. The measurement will be obtained from the sample container headspace of a half-filled, 8- or 16-ounce jar. Each soil sample shall be split into two jars, the two sub-samples shall be brought to a temperature of between 20° C. (68° F.) and 32° C. (90° F.), and the readings shall be obtained 5 to 30 minutes thereafter. One of the FID readings shall be obtained with the use of an activated charcoal filter unless the unfiltered reading is non-detect. The total corrected measurement shall be determined by subtracting the filtered reading from the unfiltered reading. A photo ionization detector (PID) may also be used, but shall not be used in situations where humidity will interfere with the instruments sensitivity (including periods of rain, measuring wet or moist soil). If an instrument with a PID is used, a filtered reading is not warranted and therefore sample splitting is not necessary.

The text will also be amended to indicate that the AQR Color-Tec® method will be conducted in accordance with EPA's Standard Operating Procedures for Analysis of Total Chlorinated Ethenes in Soil and Groundwater Using the Color Tec Screening Method and AQR Color-Tec® Method Procedures Manual. The EPA SOP and AQR Color-Tec® Method Procedures Manual will be included in the UFP-SAP.

19. Worksheet No. 8, Field Project Implementation (Field Project Instructions), Section 8.1.2, Monitoring Well Installation and Development, Page 55 of 89

Worksheet No. 8, Section 8.1.2 does not provide specific information on the proposed well construction and design. *Detailed information on well construction (PVC, steel, etc.), well*

diameter, sand pack, screen lengths, etc., should be provided in this section of the Work Plan. Revise Worksheet No. 8 to include additional details on well construction and design to ensure that they are appropriate for the goals of the investigation.

Response: Worksheet No. 8 is now Worksheet No. 14. Below is text to be added to Section 14.1.3 Monitoring Well Installation and Development.

Each new shallow monitoring well will be advanced to a depth of approximately 15 feet bls and screened across the water table. The depth of the intermediate and deep monitoring wells will be determined based on data collected from borings completed to the marine clay layer, which is at approximately 70 feet bls. At the locations of the new intermediate and deep monitoring wells, groundwater samples will be collected with a Hydro-Punch® at five foot intervals and field screened with AQR Color-Tec®. The FOL will select screen interval depths for the intermediate and deep wells based on inspection of the soil cores and identification of the more transmissive lithologic zones, which are expected to be within the respective intermediate and deep sand layers shown in the CSM (Figure 10-6), i.e., within the "Sand, Very Fine to Fine Grained" layer located directly below the "Organic Peat Layer", and within the "Sand" layer that overlies the "Clayey Sand" layer. Attachment 9 contains figures showing existing and proposed monitoring well locations (Figure 17-2) and a cross section (Figure 17-3) that illustrates the proposed and existing monitoring wells and trichloroethene concentration in 2005 and 2006.

Each shallow monitoring well will be constructed of nominal 2-inch diameter, schedule-40 polyvinyl chloride (PVC) with 10 feet of 0.10-inch slotted screen and PVC end-cap or well point at the bottom of each well. Each intermediate and deep monitoring well will be constructed of nominal 2-inch diameter, schedule-40 polyvinyl chloride (PVC) with 5 feet of 0.10-inch slotted screen and PVC end-cap or well point at the bottom of each well. The outside annular space of each well screen and adjacent formation sands will be filled with 20/30 silica sand to 2 feet above the well screen. In addition, a minimum 1 foot of fine choke sand (30/65 graded) will be placed above the sand pack for the shallow monitoring wells. The intermediate and deep monitoring wells will have a bentonite seal, a minimum 1 foot, placed above the sand pack.

Each monitoring well will be properly grouted above the sand pack or bentonite seal using neat Type II Portland cement and completed in a flush mount 8-inch diameter bolt down at grade well vault capable of supporting traffic loads. Each monitoring well vault will be emplaced in 6-inch thick, 2-feet by 2-feet flush mount pad so that the edges are flush to the ground surface. A water-tight locking well cap will be provided for each monitoring well.

Upon completion and allowing sufficient time for the grout to cure (minimum 24 hours), each shallow, intermediate and deep monitoring well will be developed by over pumping with a peristaltic pump until it produces relatively sediment free water as determined by the Tetra Tech's onsite personnel.

Monitoring well installation will be conducted in accordance with EPA Field Branches Quality System and Technical Procedures, November 1, 2007, Section 3.1, FDEP's SOPs and in compliance with the Northwest Florida Water Management District rules and regulations.

A new appendix will be created in the UFP-SAP for the EPA Field Branches Quality System and Technical Procedures.

20. <u>Worksheet No. 8, Field Project Implementation (Field Project Instructions), Section 8.1.2, Monitoring Well Installation and Development, Page 55 of 89</u>

The last sentence of the first paragraph of Worksheet No. 8, Section 8.1.2 indicates that all boring locations will be hand augered to four feet below land surface (bls*). The reported depth for hand*

augering is inconsistent with that presented in Worksheet No. 7, Sampling Design and Rationale, which notes that "soil borings… will be initiated with a stainless steel hand auger from the land surface to the water table (approximate depth 6 feet bls)..." Revise the Work Plan to state a consistent approach for the initial clearing of the boreholes.

Response: The sentence in Worksheet # 7 (now Worksheet # 17) "Soil borings at new monitoring well cluster locations will be initiated with a stainless steel hand auger from the land surface to the water table (approximate depth 6 feet bls) to confirm utilities are not present." will be modified. This text is now in Section 14.1.3 Monitoring Well Installation and Development and will be revised to read: Soil borings at new monitoring well cluster locations will be initiated with a stainless steel hand auger from the land surface to a depth of four feet bls to confirm utilities are not present.

Minor Comments

1. Worksheet No. 5, Data Quality Objectives/Systematic Planning Process Statements, Section 5.3, Study Boundaries, Page 45 of 89

   The second paragraph of Worksheet No. 5, Section 5.3 includes an incomplete sentence. *The sentence states "Data that is representative of groundwater that may have been impacted by migrating contaminants in the intermediate and deep zone." Revise this sentence into a complete sentence or delete it from the Work Plan as appropriate*.

Response: The incomplete sentence will be deleted.

ATTACHMENT 1
EPA Follow on Comments

EPA Follow on Comments
(Dated December 20, 2011)

General Comments

General Comments related to overall approach (any discrepancies between GC 1-4 and other should defer to GC's 1-4):

1) The warehouse sampling will need to be incorporated into the site plan; however, the Navy can separate this into another investigation at a later time. The time frame should be indicated.

Response: The Navy agrees that an investigation of Building 3221 will be conducted. Request for funding for this activity will be completed as funding is made available.

2) UFP-QAPP needs to be followed. Negotiation on a Tier 2 UFP-QAPP can be discussed for other sites in the future.

Response: Comment acknowledged, the Tier 2 UFP-SAP for OU 19, Site 44 will be revised to the format that has been accepted by the EPA, FDEP and Navy.

3) Analytical Suite: TAL and TCL will be run on samples for all existing MWs in the first round of sampling. If contaminants are detected in existing MWs above their constituent-specific RSLs during the first round of sampling, additional sampling for those constituents will continue in (at least) the subsequent two rounds. Regardless of the level of detection in the first round, samples will be collected from all wells and analyzed for manganese in rounds 1-3.

Response: Below on pages 7 through of 8 of 8 is a response to the above comment and to a related subsequent EPA comment which was received by email on Monday, January 30, 2012.

4) Installation of additional MWs: If contaminants are detected in existing MWs above their constituent-specific RSLs during the first round of sampling, the team will determine the location of additional wells to be installed to evaluate plume migration/stability. The decision will be based on the magnitude of contamination; whether constituent specific contamination has increased or decreased since the last sampling event; the pattern of contamination; the constituent-specific behavior of those contaminants in the environment; and updated potentiometric maps for the unit.

Response: Comment acknowledged. As stated in the UFP-SAP, the data will be evaluated by the NAS Pensacola Team to optimize the number of shallow monitoring wells and specific parameters to be sampled at each well during subsequent monitoring events and to determine the locations of four new well clusters to further characterize the vertical extent of contamination. The hydraulic upgradient and downgradient monitoring well cluster locations will each include a shallow, intermediate and deep well. The two in-plume monitoring well cluster locations will include intermediate and deep wells that are expected to be co-located with existing shallow monitoring wells.

Comments 1-6 of the RTCs, specifically. The responses appear to be adequate; however, all of the comments indicate additional text, figures, or appendices will be added to the Work Plan. The final version of the document will require review to verify that the additional text, figures, and appendices have been incorporated appropriately.

Response: Comment acknowledged, the final document will include the updated information.

Specific Comments

Comment 1: The response is adequate; however, the final version of the document will need to be reviewed to ensure the Field Task Modification Request (FTMR) form is included in the document.

Response: Comment acknowledged, the final document will include the updated information.

Comment 2: The response is adequate; however, to eliminate confusion regarding the sequencing of dates at Building 3221, please incorporate the third paragraph of the response into the final version of the document.

Response: Comment acknowledged, the final document will include the requested information.

Comment 3: The response is adequate provided that the additional text is incorporated into the final version of the document.

Response: Comment acknowledged, the final document will include the updated information.

Comment 4: The response is partially adequate. The age of the sewer system at the site has not been described. Additionally, please incorporate the response into the final version of the document, or include Attachment 2 as supporting documentation. Additionally, provide the age of the sewer system.

Response: The final document will include a design drawing (Attachment 4) that shows the sewer system and its connection to Building 3221 and the following text: "The first and second phase construction drawings for Building 3221 have design dates of 1964 (Submittal Date) and 1966 (Record Drawing Date). The drawings indicate that existing gravity sewer lines were present in the area of Building 3221 prior to its construction. When Building 3221 was constructed, the sewage from the building was conveyed to a lift station via gravity flow and then pumped to an existing gravity sewer system."

Comment 5: The response is adequate. However, the new information about waste oil disposal prior to initiation of contractor reprocessing/recycling in 1983 requires further clarification. The response notes, "Historical methods of disposal of waste oil at NAS Pensacola included removal by contractor, disposal through the [industrial wastewater treatment plant] IWTP, and disposal to the crash crew fire training activity. Please clarify how wastes were transmitted to the crash crew fire training activity, identifying any locations where the wastes may have been stored or handled prior to transport.

Response: There is no additional available information on where the waste may have been stored and handled prior to being transported for the crash crew fire training activity.

Comments 6: The response is adequate provided that the additional text is incorporated into the final version of the document.

Response: Comment acknowledged, the final document will include the updated information.

Comment 7: The response is adequate.

Response: Comment acknowledged.

Comment 8: The response is adequate provided that the information in the first paragraph of the response is incorporated into the revised document as this provides an additional line of evidence that Building 3221 is likely not the source of the groundwater contamination.

Response: Comment acknowledged, the final document will include the updated information.

Comment 9: The response requires further clarification. The first paragraph on Page 9 of 15 states, "The use and material(s) stored of the small building is unknown." However, the third paragraph indicates the un-numbered structure is a portable metal shed mounted on a trailer, built to store products in support of the Naval Aviation Museum Foundation air show sales program. It is further noted that "No chemicals have been stored in this structure." Please address the discrepancies in the use and material storage of the small un-numbered structure discussed in the response.

Response: Below is the revised response for Comment 9.

The small building east of Building 3629 is not apparent in an aerial photograph taken on October 11, 1993 (Photograph 8 in Attachment 5), but appears in two aerial photographs one taken on February 15, 1997 and the other taken on February 15, 2000 (Photographs 9 and 10 in Attachment 5. The building does not appear in an aerial photograph taken on March 12, 2004 (Photograph 11 in Attachment 5). Based on the a review of the 1993 Contamination Assessment Report (CAR), the small building was not present at the time the assessment activities were conducted and the CAR indicated that Building 3629 was a flammable storage area and a possible source for the chlorinated solvents. The use and material(s) stored in Building 3629 and the adjacent small building is described below.

Building 3629 is an open-sided shed that was assigned by NAS Pensacola to be part of the facilities for Hangar 3221 that were to be operated by the National Naval Aviation Museum (NNAM) after the Naval Aviation Depot (NADEP) vacated the building. The open-sided shed was originally located adjacent to and northwest of the 3221 wash rack (about 60 yards west of Hangar 3221 west wall). The concrete slab that held the structure is still in place. In about 2000, it was moved to its present location immediately adjacent to the west wall of Hangar 3221. Before being moved, this building was used for storage of a few pieces of rolling stock and also held storage lockers for HAZMAT, primarily acetic acid and a corrosion inhibitor (commercial name: "Corrosion Block"). This storage had the approval of NAS Pensacola Safety authorities. Its present use is for the storage of equipment primarily used at the wash rack and some other small rolling stock. Chemicals have not been stored in the structure since it was moved.

The un-numbered structure was a portable metal shed mounted on a trailer. It was originally built to store products (believed to be items such as souvenirs and programs) in support of the Naval Aviation Museum Foundation (the private support organization for the air show sales program). During this time, it was located on the 3221 aircraft parking line or adjacent to Building 3695 (NNAM Exhibits Fabrication Building), which is off site from Hangar 3221. Following the Foundation's termination of the air show sales program, the structure has been used by NNAM for storage of line gear (e.g., tie-downs, chocks, etc.) and other dry storage. No chemicals have been stored in this structure.

Comments 10 through 13: The responses to these comments are adequate provided that the requested changes are made to the revised document.

Response: Comment acknowledged, the final document will include the updated information.

Comment 14: The response to this comment is adequate provided that these lines of evidence are incorporated into the revised document.

Response: Comment acknowledged, the final document will include the updated information.

Comment 15: The response is adequate provided that the requested change is made to the revised document.

Response: Comment acknowledged, the final document will include the updated information.

Comment 16: The response is adequate. However, please make sure that any water in the sampler is purged prior to advancing to the next depth interval. Any equipment used to extract the sample (i.e., tubing/pump or bailer) should be decontaminated between samples, or dedicated equipment should be used.

Response: The final document will include text stating : "any water in the sampler will be purged prior to advancing to the next depth interval and any equipment used to extract the sample (i.e., tubing/pump or bailer) will be decontaminated between samples, unless dedicated equipment is used."

Comments 17 through 20: The responses are adequate provided that the additional text and appendices are incorporated into the revised document.

Response: Comment acknowledged, the final document will include the updated information.

<u>Minor Comments</u>

Comment 1: The response is adequate provided that the final document is updated appropriately.

Response: Comment acknowledged, the final document will include the updated information.

Additional EPA Comments, NAS Pensacola Partnering Team Teleconference Meeting January 17, 2012

EPA requested that soil samples be collected at three locations, one north of the foundation for former Building 3629, and two southeast of the foundation for former Building 3629. The soil samples are to be analyzed by the EPA Contract Laboratory Program (CLP) for TCL volatile organics, TCL semi-volatile organics, TCL pesticides and polychlorinated biphenyls (PCBs) and TAL inorganics. The purpose of the additional soil samples is to supplement existing TCL/TAL soil sample results in the RI to confirm related direct soil exposure human health risk conclusions and potential sources for contaminant leachability to groundwater.

Response: Attachment 9 contains Figure 17-1 that shows the locations proposed for the three soil borings. This figure will be included in the revised UFP-SAP. Soil samples will be collected at 2-foot intervals from the land surface to the water table (estimated 6 feet bls). The soil samples will be screened in the field with an OVA FID/PID and AQR Color-Tec®. Two soil samples will be collected from each boring. One surface sample (land surface to two feet bls) will be collected at each location. The subsurface soil sample from each location will be selected by the Field Operations Leader to represent the highest of the field screening measurements (OVA FID/PID and/or AQR Color-Tec®) or staining or olfactory observations. In the event that OVA and AQR Color-Tec® data do not indicate the presence of volatile organics and there is no obvious staining or olfactory observations, the soil samples will consist of a surface soil sample (0 to 2 foot bls) and a subsurface soil sample from the 2-foot interval above the water table encountered at the time of the field activities. The soil sampling procedures and equipment decontamination will be conducted in accordance with EPA SESD procedures with the exception of field screening with the OVA FID/PID. Field screening with the OVA FID/PID will be conducted in accordance with the FDEP procedure described previously in Specific Comment 18. The soil samples will be submitted for off-site laboratory analysis for USEPA CLP TCL VOCs, SVOCs, pesticides, PCBs and USEPA CLP TAL metals.

Additional EPA Comments Received by EMAIL

Email dated Tuesday, January 24, 2012:

We reviewed the reports and the data base you sent and it appears that TCL/TAL were only analyzed in Dec 2005 based on our review of the information. Lots of analyses appears to have been performed prior but not full TCL/TAL. Are we off base? Can you please verify, as we would like to complete our review. Below is a draft table we prepared to help us sift through the data.

SAMPLE DATE	WELLS SAMPLED	ANALYSES
January 25, 1992	PEN-3221SW-MW-1, PEN-3221SW-PZ1 through PEN-3221SW-PZ3	Volatile organic compounds (VOCs) by EPA Method 624, base-neutral and acid extractables (BNA) by EPA Method 625, total metals (arsenic, cadmium, chromium, and lead only), and total recoverable petroleum hydrocarbons (TRPH)
April 15, 1992	PEN-3221SW-MW- 1 through PEN-3221SW-MW-5	VOCs (EPA Method 624), BNA (EPA Method 625), total metals (arsenic, cadmium, chromium, and lead only), and TRPH
August 29, 1992	PEN-3221SW-MW-1 through PEN-3221SW-MW-10 (also known as PEN-3221-1 through PEN-3221-10)	VOCs (EPA Method 624), BNA (EPA Method 625), total metals (arsenic, cadmium, chromium, and lead only), TRPH
May 11, 1994	Temporary Monitoring Well TW-1	VOCs (EPA Method 624), BNA (EPA

SAMPLE DATE	WELLS SAMPLED	ANALYSES
		Method 625), total metals (arsenic, cadmium, chromium, and lead only), TRPH
December 13 or 14, 2005	PEN-3221SW-MW-1 through PEN-3221SW-MW-10 (also known as PEN-3221-1 through PEN-3221-10), PEN-44-09 to PEN-44-15, PEN-44-18 and PEN-44-19	Full TCL/TAL list plus TPH
May 9 or 10, 2006	PEN-3221-03, PEN-44-15, PEN-44-18, PEN-44-19	Manganese , iron, lead, and/or bis(2-ethylhexyl)phthalate, depending on the well sampled
May 12, 2006	PEN-44-16 and PEN-44-17, PEN-44-20 to PEN-44-22	Chlorinated VOCs only (via 8260B)
August 14, 2006	PEN-44-23 to PEN-44-26	Chlorinated VOCs only (via 8260B)

TechLaw was unable to verify that two rounds of TCL/TAL groundwater data were collected at the site; therefore, TechLaw is recommending that an additional round of TCL/TAL analyses be conducted at the site in all monitoring wells to supplement existing data and to verify the results from the initial round of TCL/TAL sampling in December 2005.

Response: We acknowledge that full TAL/ TCL analysis was not completed on site 44 groundwater samples during two separate events in 2005 and 2006. However we believe that extensive representative groundwater analysis has been completed for the monitoring wells at the Site 44 as is presented in the table in Attachment 7 that provides a summary of groundwater sampling events and analytical methods. This table lists the monitoring wells that were analyzed by EPA Methods 624 and 625 and the TCL VOCs, TCL SVOCs, TCL Pesticides and PCBs and TAL metals. The table shows that "TAL/TCL equivalent" analysis was completed for each monitoring well (one well was analyzed three times and five wells analyzed twice) using analytical methods that are comparable to TCL/TAL during the petroleum investigation phase (1992 to 1994) of the site investigations. The table also shows that, during the RI (2005 and 2006) one round of TAL/TCL analysis was conducted for source area monitoring wells. Specifically it should be noted that:

- **Site 44 was initially identified and investigated as a petroleum site. As part the initial petroleum investigation in 1992 the site groundwater was sampled and analyzed in accordance with Florida regulation in effect at that time for VOCs via EPA Method 624, SVOCs via EPA Method 625, select metals (arsenic cadmium, chromium, and lead) and TRPH EPA Method 418.1. The specific compounds analyzed by EPA Methods 624 and 625 is comparable to the TCL list for VOCs and SVOCs. The attached list in Attachment 8, which provides a comparison of the analytes and analytical methods used at Site 44, indicates that there is significant overlap between the analytes in the list.**

- **TAL/TCL analysis was completed on groundwater samples from all available monitoring wells in 2005 and was specifically completed on the monitoring wells located in the Site 44 source areas that are described in the UFP-SAP. Attachment 7 provides a figure that illustrates the monitoring well locations that had groundwater samples analyzed by EPA Method 624/625; TAL/TCL, and cVOCs only.**

- **In 2006 the COC list was pared to only analysis of cVOCs which is a responsible "best practice" procedure used by the Navy. It should be noted that in 2006, groundwater samples were collected and analyzed for only cVOCs from the perimeter (hydraulic sidegradient and downgradient locations) monitoring well locations and the source area monitoring wells were**

not sampled because previous analytical results from the source area monitoring well locations had indicated that cVOCs were the only COCs at concentrations exceeding regulatory criteria.

EPA Follow Up Email Comment dated Friday, January 27, 2012:

EPA has reviewed the information provided in this response and has decided that 1 round of full scan samples should be performed in the groundwater to supplement the current information at Site 44. The rationale is that the TAL/TCL scan has been updated since full scan sampling was performed at the site. There are constituents that may not have been sampled at the site. TCL list available online at: http://www.epa.gov/superfund/programs/clp/target.htm.

EPA Follow Up Email Comment dated Monday, January 30, 2012 (EPA modified their request in the above comment based on discussions with the Navy RPM and requested TCL/TAL analyses be performed for only a partial list of the existing wells at Site 44, based on stated rationale, and for the new intermediate depth wells):

Here's a list:

PEN-3221-03: former UST well; previously reported manganese above screening criteria

PEN-3221-04: located immediately downgradient of former UST

PEN-3221-06: located just outside southwest corner of Building 3221; previously reported naphthalene above the tapwater RSL

PEN-3221-09: TCE detected above screening criteria

PEN-3221-8 and 10: located in former staging area adjacent to Building 3221; TCE previously detected in 3221-10 above screening criteria but not during 2005/06 sampling rounds

PEN-44-09: located downgradient of Building 3629; soil sample from boring 44SB02 near this building reported pesticides above migration to groundwater screening criteria; chloroform also detected in groundwater (0.8 J ug/l) above current RSL of 0.19 ug/l

PEN 44-11: TCE detected above screening criteria; chloroform also detected slightly above RSL

PEN-44-12, PEN-44-13: chloroform detected above current RSL

PEN-44-14: plume well with TCE exceeding screening criteria; chloroform also detected above RSL at 0.6 J ug/l

PEN-44-15: previously reported bis(2-ethylhexyl)phthalate, TCE above screening criteria (in-plume well); chloroform also detected slightly above RSL at 0.6 J ug/l

PEN-44-18: deep well within the TCE plume area; previously reported iron and manganese above screening criteria

PEN-44-19: deep well located near PEN-3221; previously reported iron, manganese, and bis(2-ethylhexyl)phthalate above screening criteria

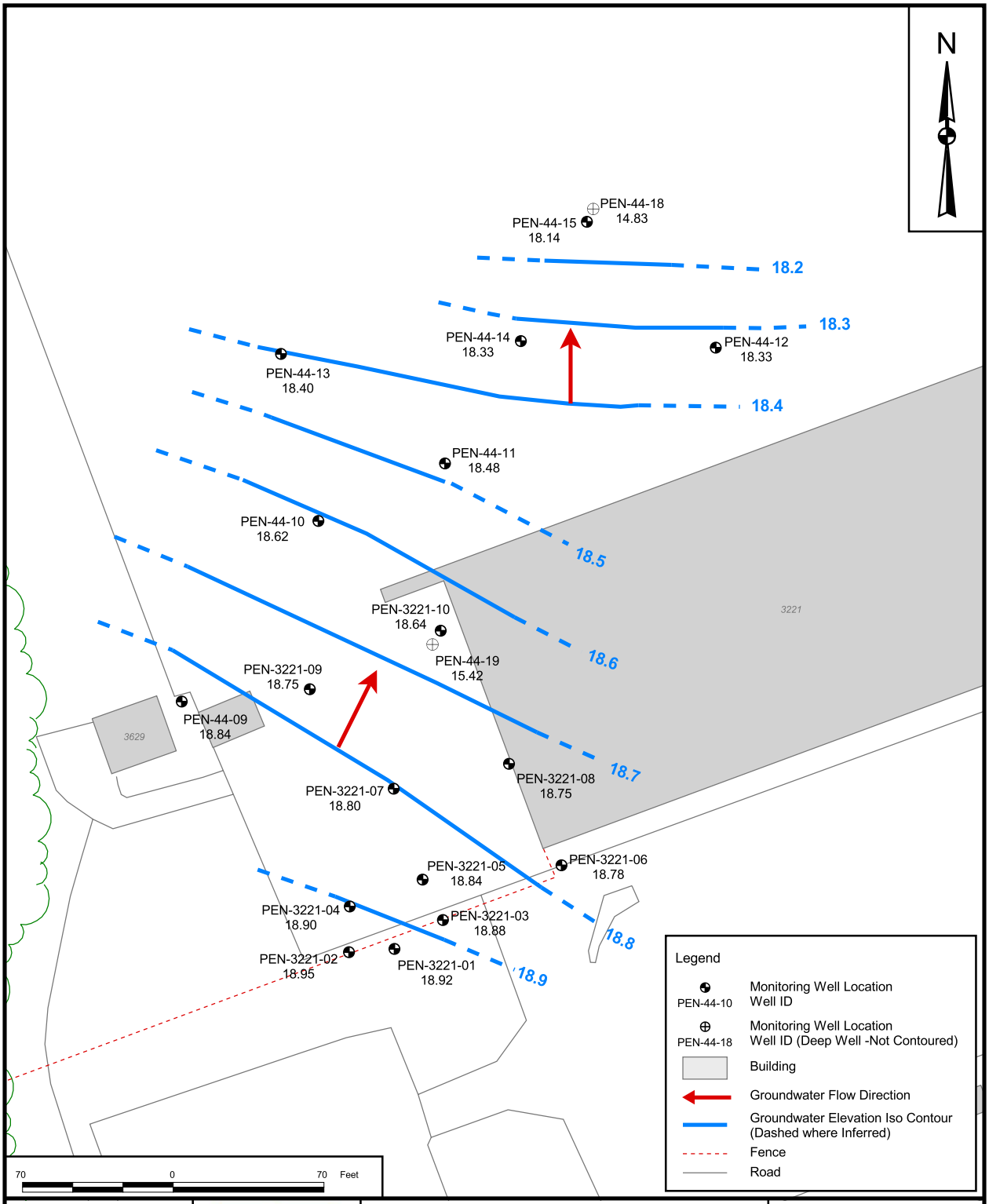
PEN-44-21, PEN-44-24: plume wells with TCE exceeding screening criteria

Also, in the recent SAP for this site, the Navy is proposing intermediate depth wells, to be screened below the organic peat layer. Since this is a portion of the aquifer that has not been sampled previously, the full TCL/TAL is recommended for intermediate wells.

Response: The Navy agrees to EPA's request to perform TCL/TAL analyses of groundwater samples collected from the monitoring wells listed in your email. This request also includes TCL/TAL analyses of groundwater samples collected from the new intermediate depth monitoring wells that are proposed to be installed under the current UFP-SAP.

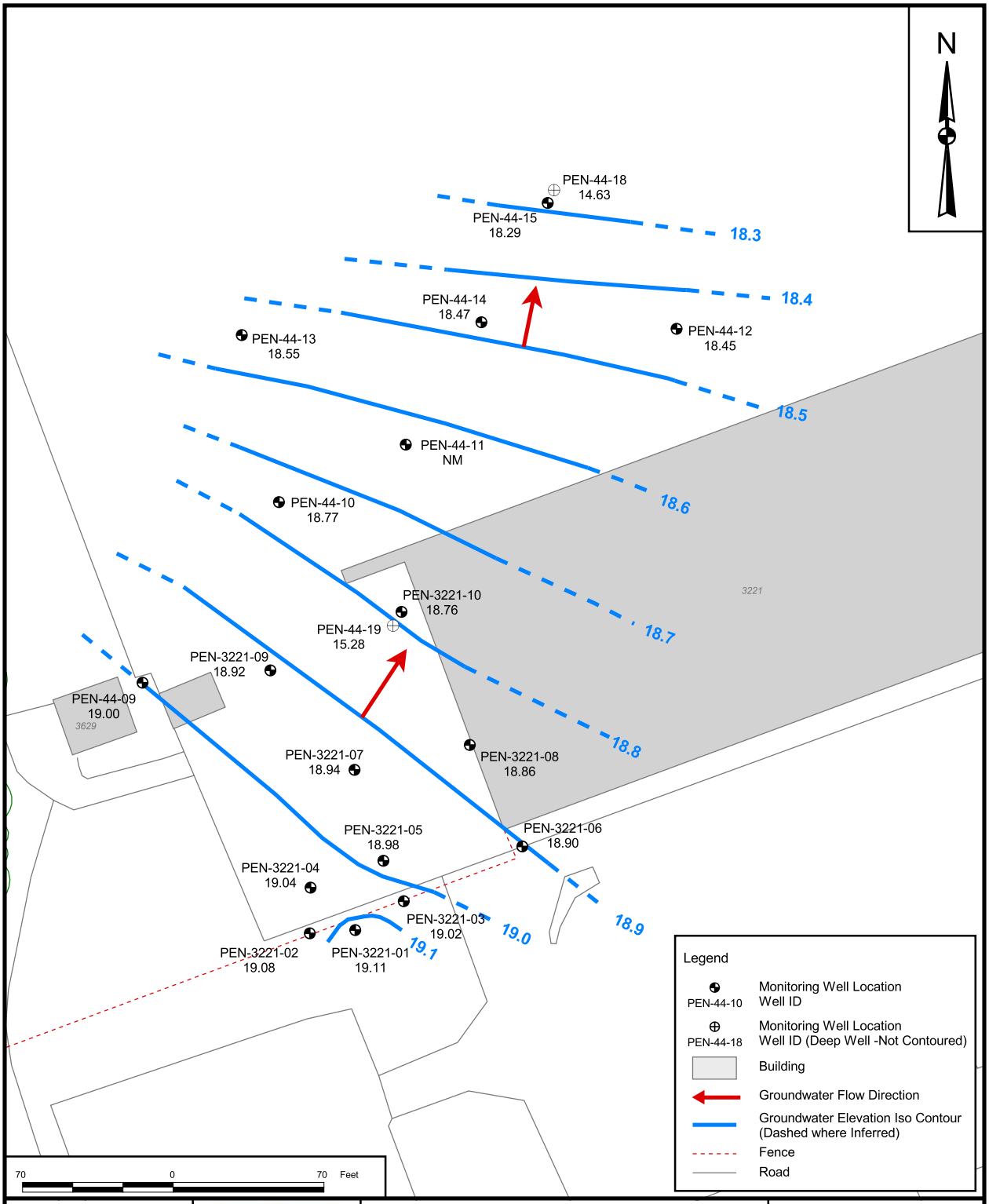
Therefore to resolve EPA's concerns and efficiently resolve the informal dispute, we concur with EPA's request and propose to include in the current UFP-SAP one round of TCL/TAL analyses for the monitoring wells listed in your email below; including the new intermediate depth wells.

ATTACHMENT 2
Potentiometric Surface Maps from the 2008 Site 44 Remedial Investigation



DRAWN BY	DATE		CONTRACT NUMBER
C. SPEHAR	1/20/06	GROUNDWATER ELEVATIONS	CTO 0367
CHECKED BY	DATE	SHALLOW MONITORING WELLS 12/06/05	APPROVED BY / DATE
B. OLSON	5/03/07	SITE 44 RI REPORT	— / —
COST/SCHEDULE-AREA		NAS PENSACOLA	APPROVED BY / DATE
		PENSACOLA, FLORIDA	— / —
SCALE			DRAWING NO. / REV
AS NOTED			FIGURE 3-2 / 0

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR MW LOCATION SITE 44 LAYOUT 5/03/07 JEE



DRAWN BY C. SPEHAR	DATE 1/20/06	GROUNDWATER ELEVATIONS SHALLOW MONITORING WELLS 12/20/05 SITE 44 RI REPORT NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0367
CHECKED BY B. OLSON	DATE 5/03/07		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-3 / REV 0

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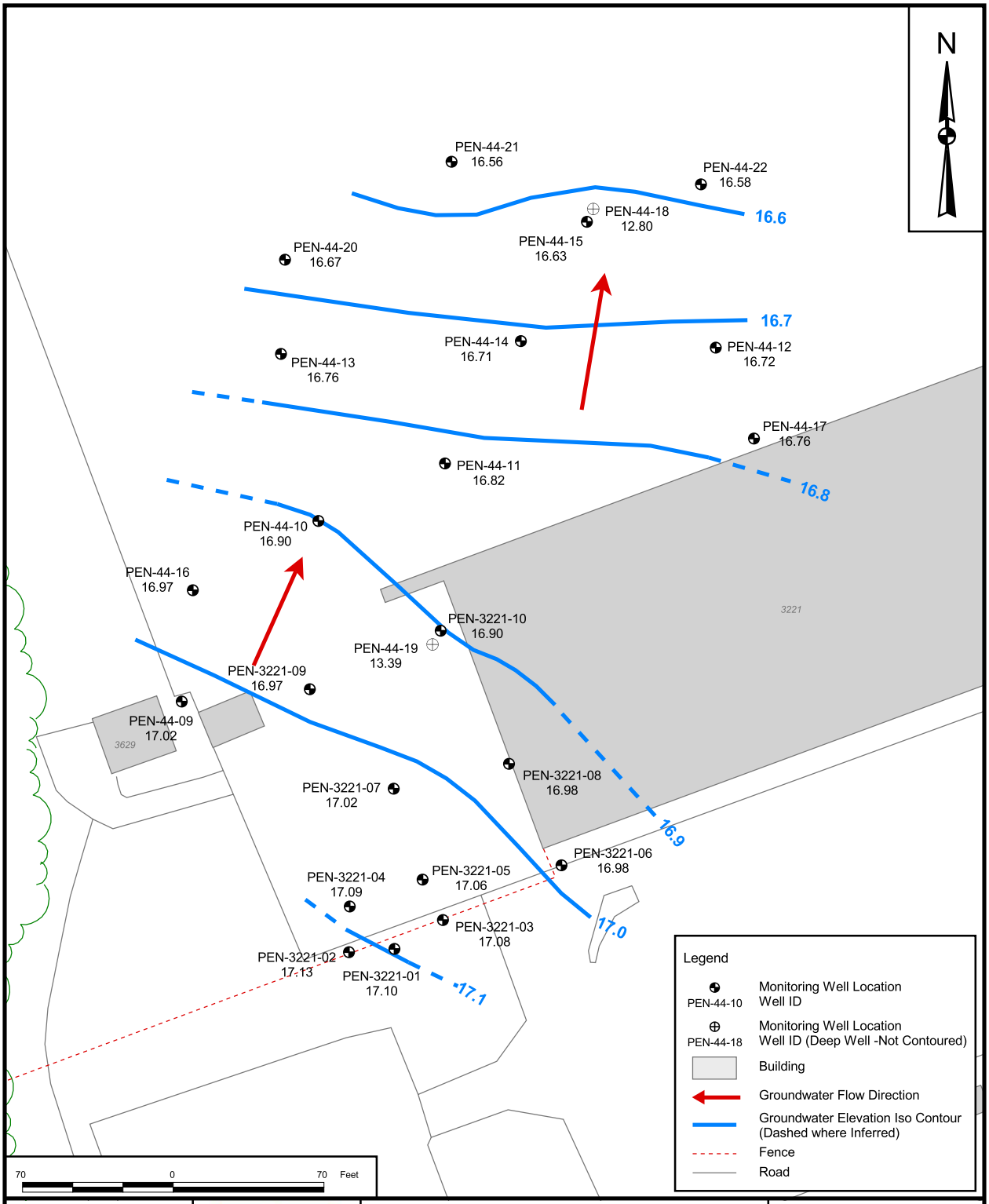

DRAWN BY C. SPEHAR	DATE 1/20/06	GROUNDWATER ELEVATIONS SHALLOW MONITORING WELLS 05/12/06 SITE 44 RI REPORT NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0367
CHECKED BY B. OLSON	DATE 4/25/07		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-4 / REV 0

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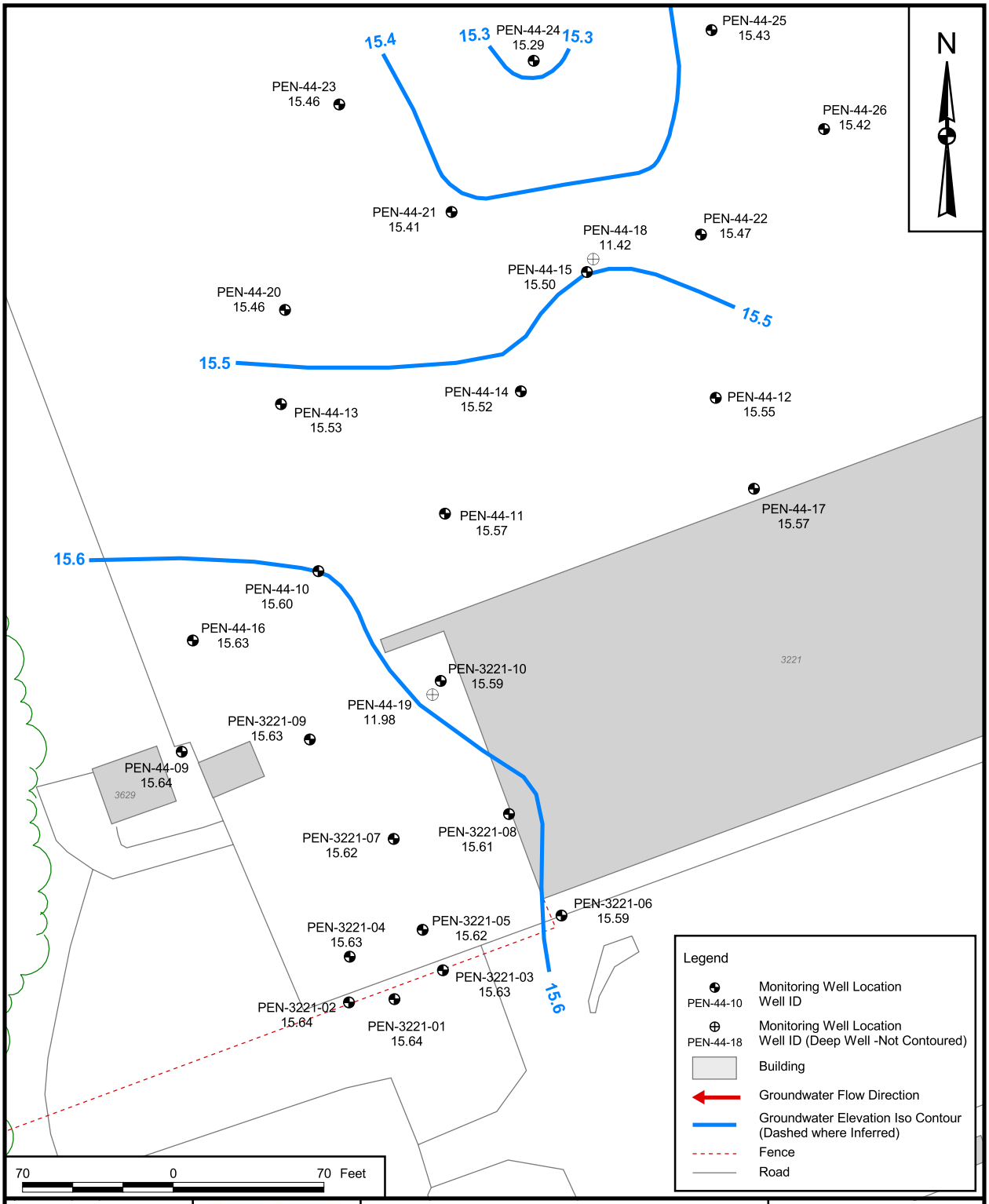


DRAWN BY C. SPEHAR — DATE 1/20/06	NAVFAC	GROUNDWATER ELEVATIONS SHALLOW MONITORING WELLS 08/14/06 SITE 44 RI REPORT NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0367
CHECKED BY B. OLSON — DATE 4/25/07			APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-5 — REV 0

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR SITE 44 POTENTIO 08142006 LAYOUT 4/25/07 JEE

ATTACHMENT 3
Field Modification Form

TETRA TECH NUS
FIELD TASK MODIFICATION REQUEST FORM

Project/Installation Name	CTO & Project Number	Task Mod. Number
Modification To (e.g. Work Plan)	Site/Sample Location	Date

Activity Description: _____

Reason for Change: _____

Recommended Disposition: _____

Field Operations Leader (Signature) _____ Date _____

Approved Disposition:

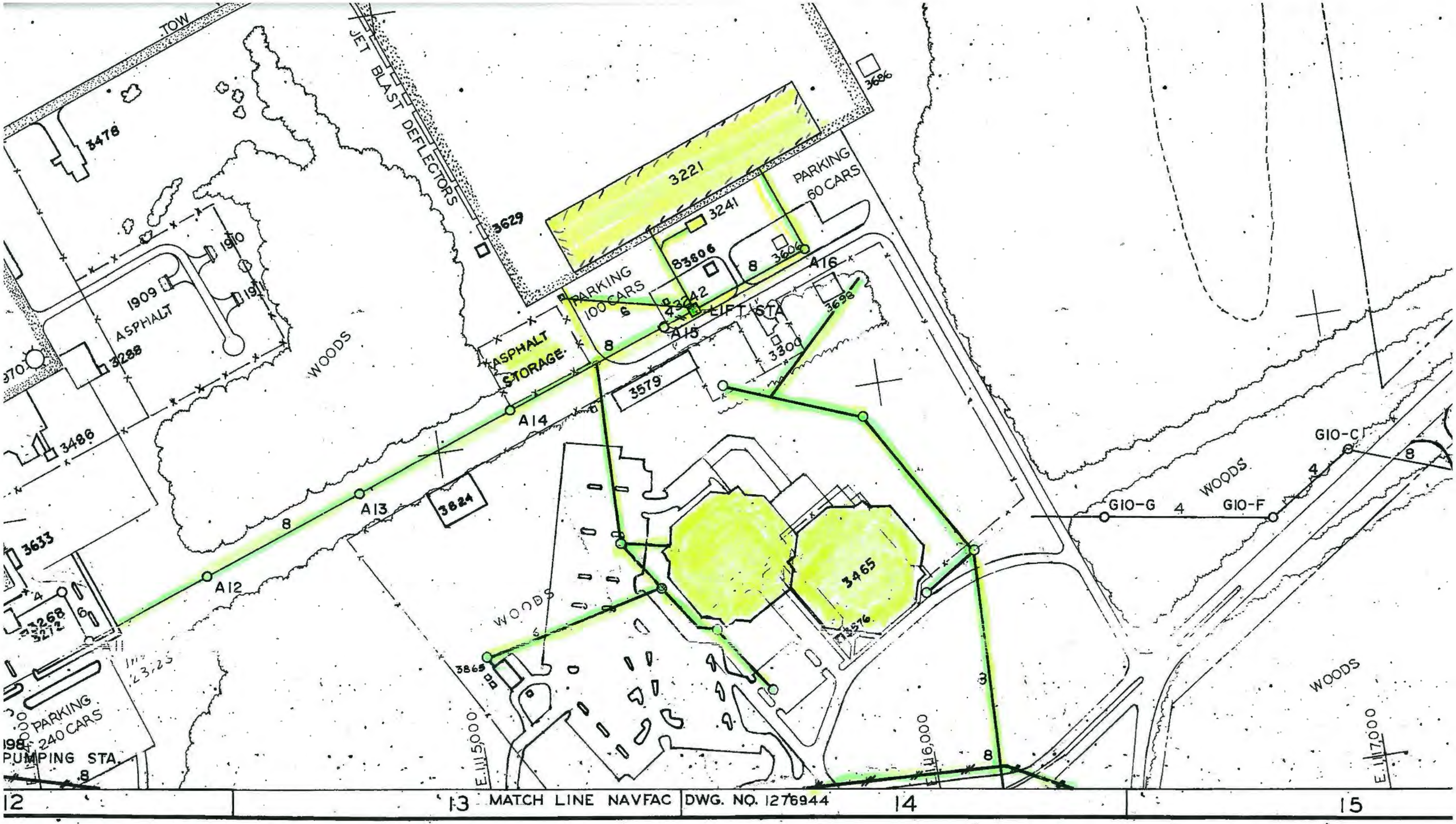
Project/Task Order Manager (Signature) _____ Date _____

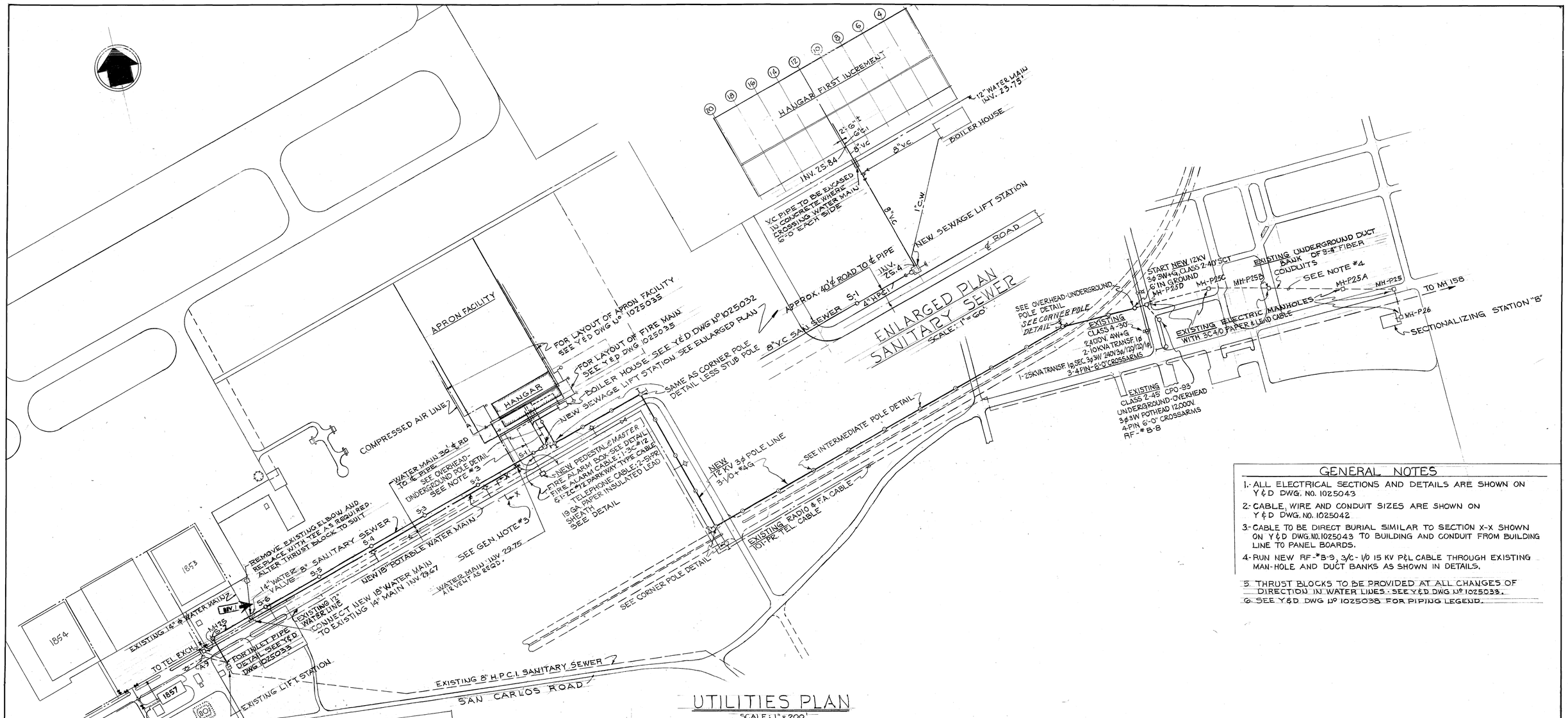
Distribution:

Program/Project File –
Project/Task Order Manager –
Field Operations Leader –

Other: _____

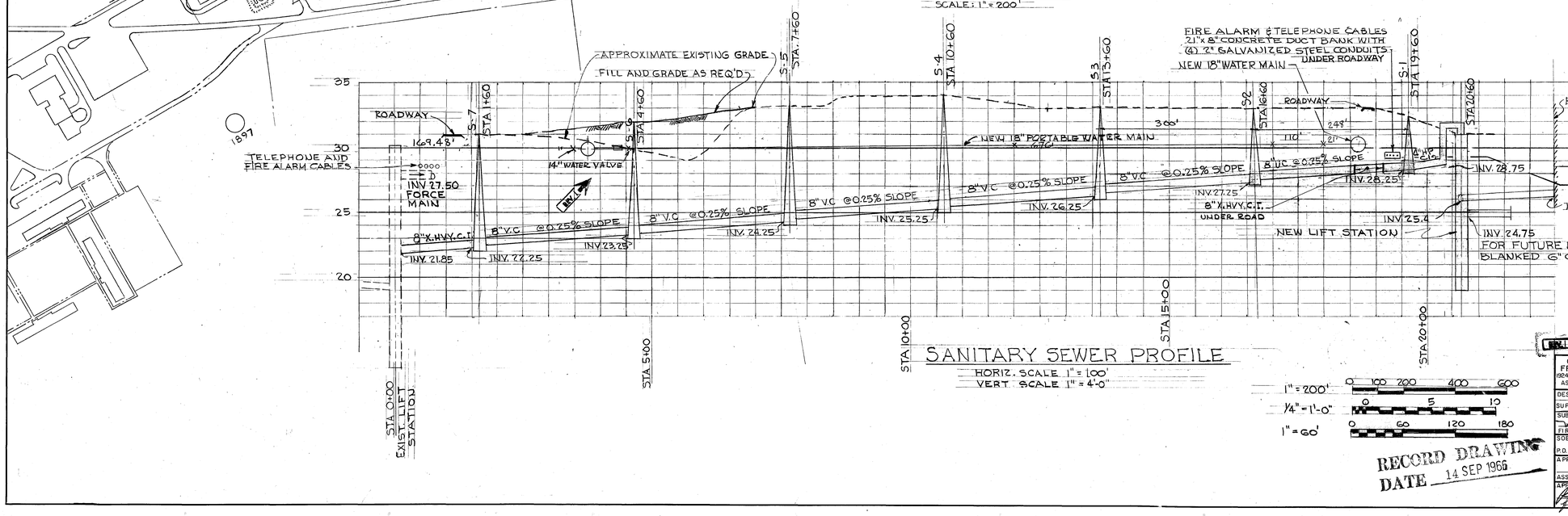
ATTACHMENT 4
Sewer System in the Vicinity of Building 3221


TOW
JET BLAST DEFLECTORS
3478
3629
3686
3221
3241
PARKING
60 CARS
PARKING
100 CARS
3606
3242
LIFT STA
A16
3698
3300
1910
1909
ASPHALT
3288
WOODS
ASPHALT
STORAGE
A15
3579
A14
3486
A13
3824
A12
3633
3268
3272
3465
3576
3865
GIO-C
GIO-G
GIO-F
WOODS
PARKING
240 CARS
PUMPING STA
E 115,000
E 116,000
E 117,000
12
13
MATCH LINE NAVFAC DWG. NO. 1276944
14
15



UTILITIES PLAN

SCALE: 1" = 200'



SANITARY SEWER PROFILE

HORIZ. SCALE 1" = 100'
VERT. SCALE 1" = 4'-0"

1" = 200' 0 100 200 400 600
1/4" = 1'-0" 0 5 10
1" = 60' 0 60 120 180

GENERAL NOTES

1. ALL ELECTRICAL SECTIONS AND DETAILS ARE SHOWN ON Y&D DWG. NO. 1025043
2. CABLE, WIRE AND CONDUIT SIZES ARE SHOWN ON Y&D DWG. NO. 1025042
3. CABLE TO BE DIRECT BURIAL SIMILAR TO SECTION X-X SHOWN ON Y&D DWG. NO. 1025043 TO BUILDING AND CONDUIT FROM BUILDING LINE TO PANEL BOARDS.
4. RUN NEW RF-#8-9, 3/C-1/0 15 KV P&L CABLE THROUGH EXISTING MAN-HOLE AND DUCT BANKS AS SHOWN IN DETAILS.
5. THRUST BLOCKS TO BE PROVIDED AT ALL CHANGES OF DIRECTION IN WATER LINES. SEE Y&D DWG Nº 1025033.
6. SEE Y&D DWG Nº 1025038 FOR PIPING LEGEND.

NOTE:

APPROXIMATE EXISTING GRADE TAKEN FROM CONTOURS SHOWN ON Y&D DWG Nº 489860. THESE CONTOURS BASED ON BENCH MARK DESCRIBED AS FOLLOWS. U.S COAST & GEODETIC SURVEY BENCH MARK Nº K9 AT WARRINGTON, ESCAMBIA COUNTY, AT THE NAVY YARD ABOUT 10 YDS. NORTH OF THE CENTER OF THE WEST ENTRANCE IN A BRICK, A STANDARD DISK STAMPED "7.792 K-9 1918 EQUALITY.
US C&GS ELEVATION = 7.792
LOCAL STATION DATUM ELEVATION = 8.00

REV.		
1	AS-BUILT DRAWING - REV. WATER VALVE	7-5-66	S.M.T.

GREEN & WALL, INC
FRANK J. SINDELAR, A.I.A.
1924 N. PALAFOX STR. PENSACOLA, FLA.
ASSOCIATED ARCHITECT - ENGINEER

DEPARTMENT OF THE NAVY
SOUTHEAST DIVISION - BUREAU OF YARDS AND DOCKS
U.S. NAVAL BASE CHARLESTON, S.C.

DES. J. Tourtellotte DR. J. Tourtellotte CHK. R. Patterson
SUPV. R. Clemson CH. ENGR. A. Simmons
SUBMITTED BY 10/7/64
FIRM MEMBER
SOEASTDOCKS ENGINEERING DIVISION
P.D.E. RICHBOURG, DIR.
APPROVED DATE
ASST. DIRECTOR FOR DESIGN
APPROVED FOR BUDOCKS DATE 10/7/64
FOR DIRECTOR FOR CHIEF OF BUREAU

U.S. NAVAL AIR STATION
PENSACOLA, FLA.
AIRCRAFT REWORK HANGAR
UTILITY PLAN

CODE IDENT. NO.
SCALE: AS NOTED
SIZE
Y & D DRAWING NO. 1025034
SPEC 48879/62
NBy 48879
SHEET 25 OF 36

RECORD DRAWING
DATE 14 SEP 1966

66

ATTACHMENT 5
Aerial Photograph Review

Aerial Photograph 1: Site 44 Area, 12-10-1961

Aerial Photograph 2: Site 44 Area, 04-07-1970

Aerial Photograph 3: Site 44 Area, 04-05-1973

Aerial Photograph 4: Site 44 Area, 03-09-1981

Aerial Photograph 5: Site 44 Area, 09-22-1983

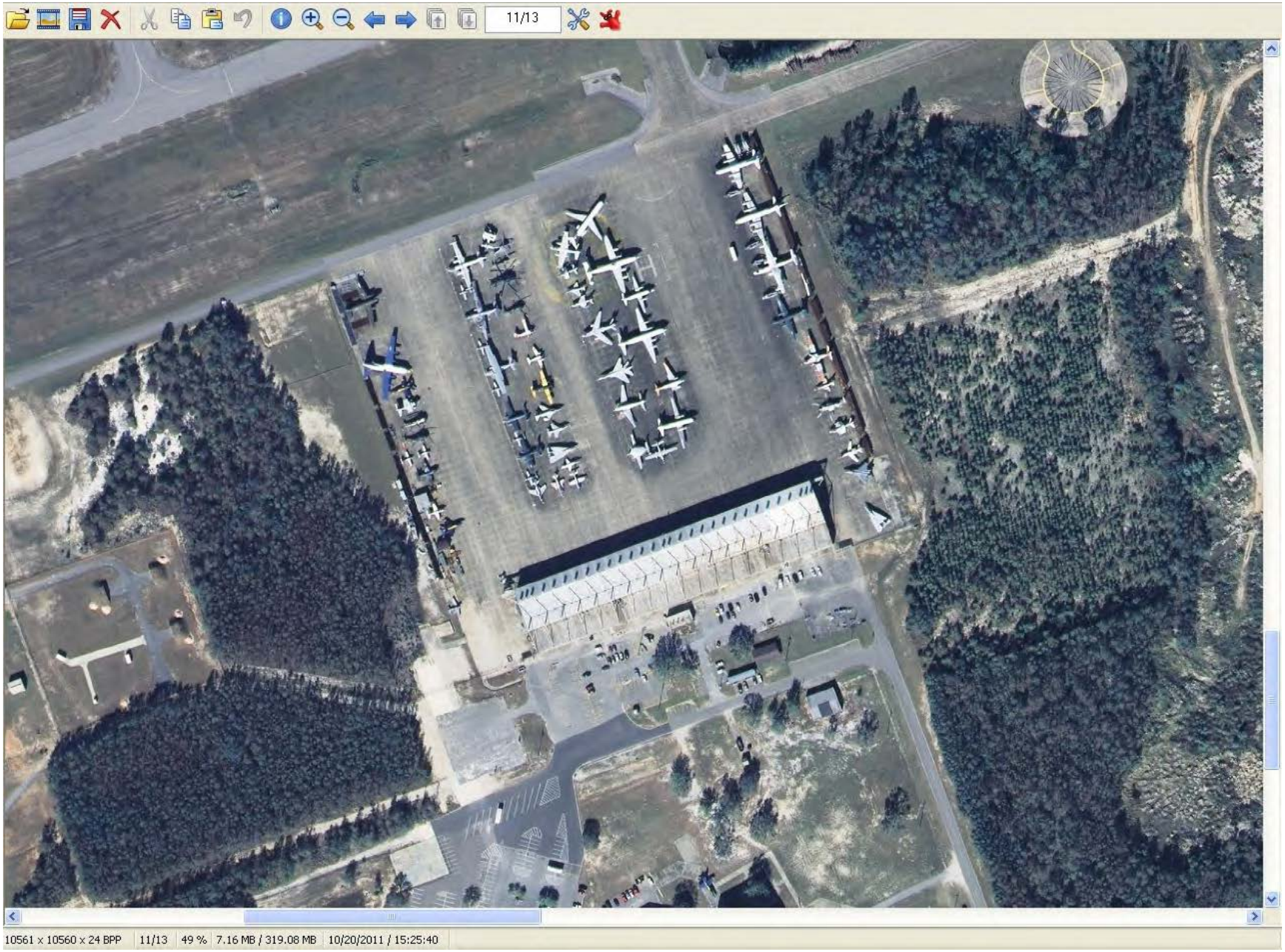
Aerial Photograph 6: Site 44 Area, 26-10-1989

Aerial Photograph 7: Site 44 Area, 14-03-1992

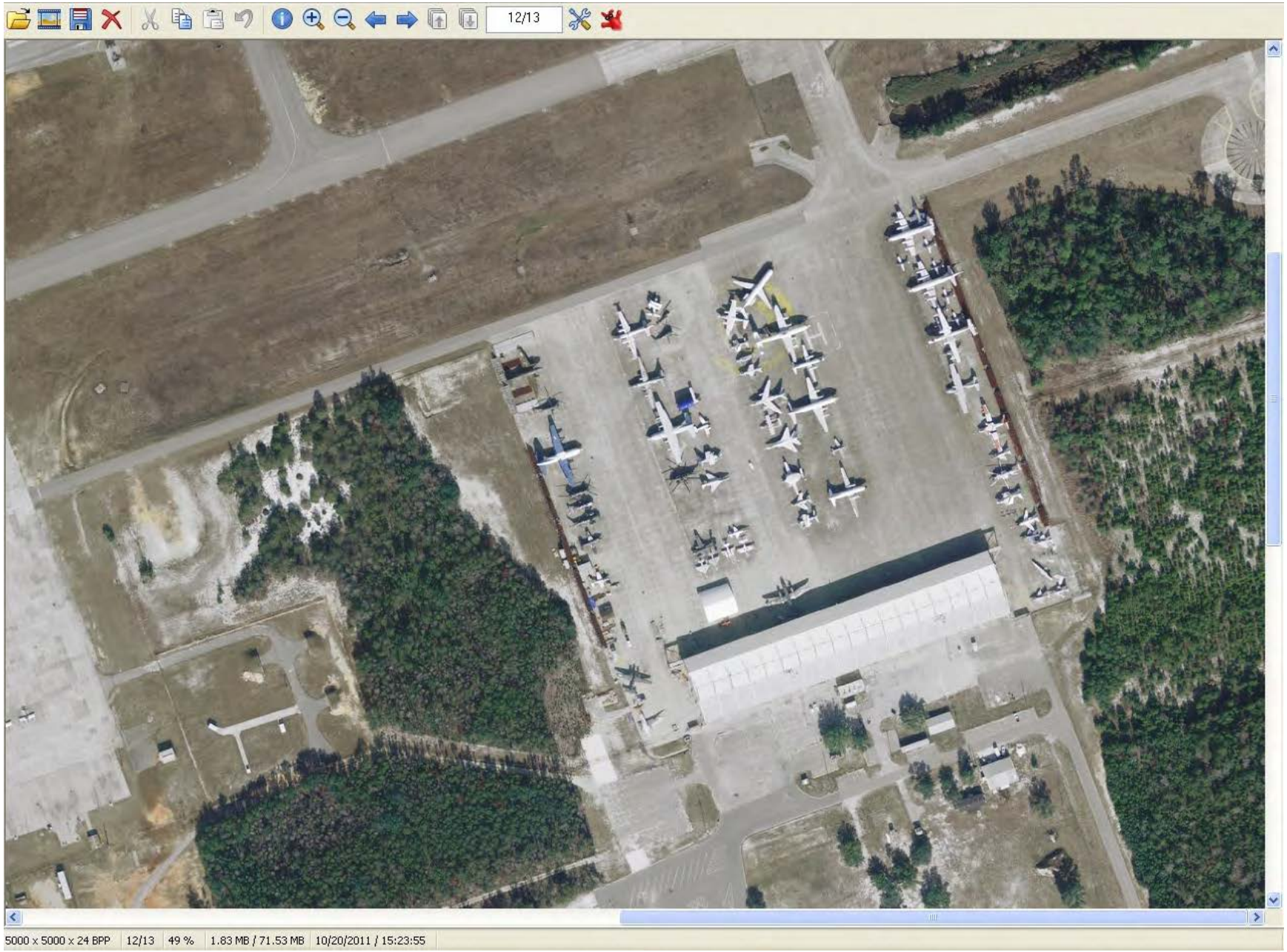
Aerial Photograph 8: Site 44 Area, 11-10-1993

Aerial Photograph 9: Site 44 Area, 15-02-1997

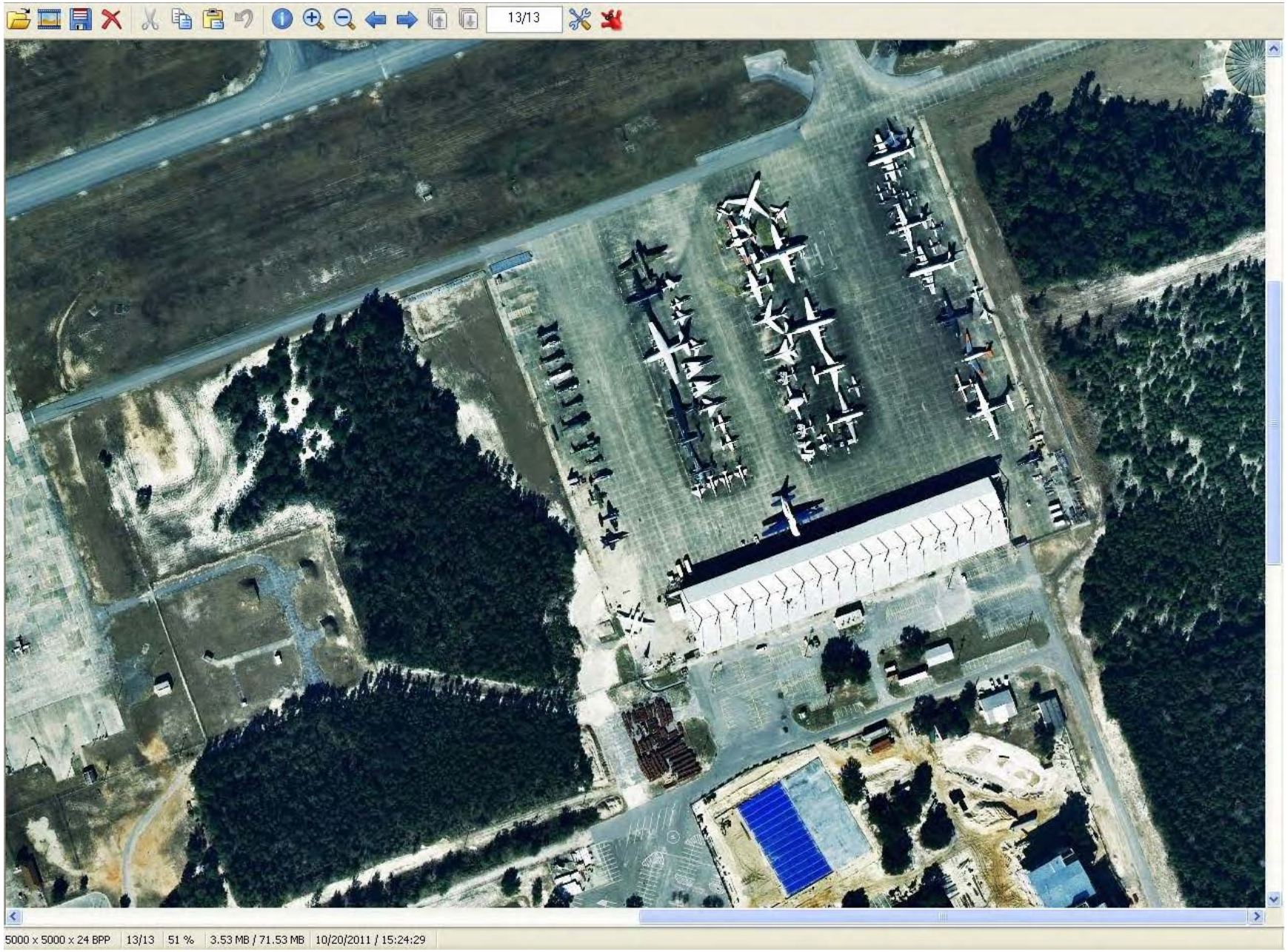
Aerial Photograph 10: Site 44 Area, 15-02-2000



Aerial Photograph 11: Site 44 Area, 12-03-2004



Aerial Photograph 12: Site 44 Area, 01-09-2007



Aerial Photograph 13: Site 44 Area, 01-10-2010

ATTACHMENT 6
Figure 5-1 from The Initial Assessment Study

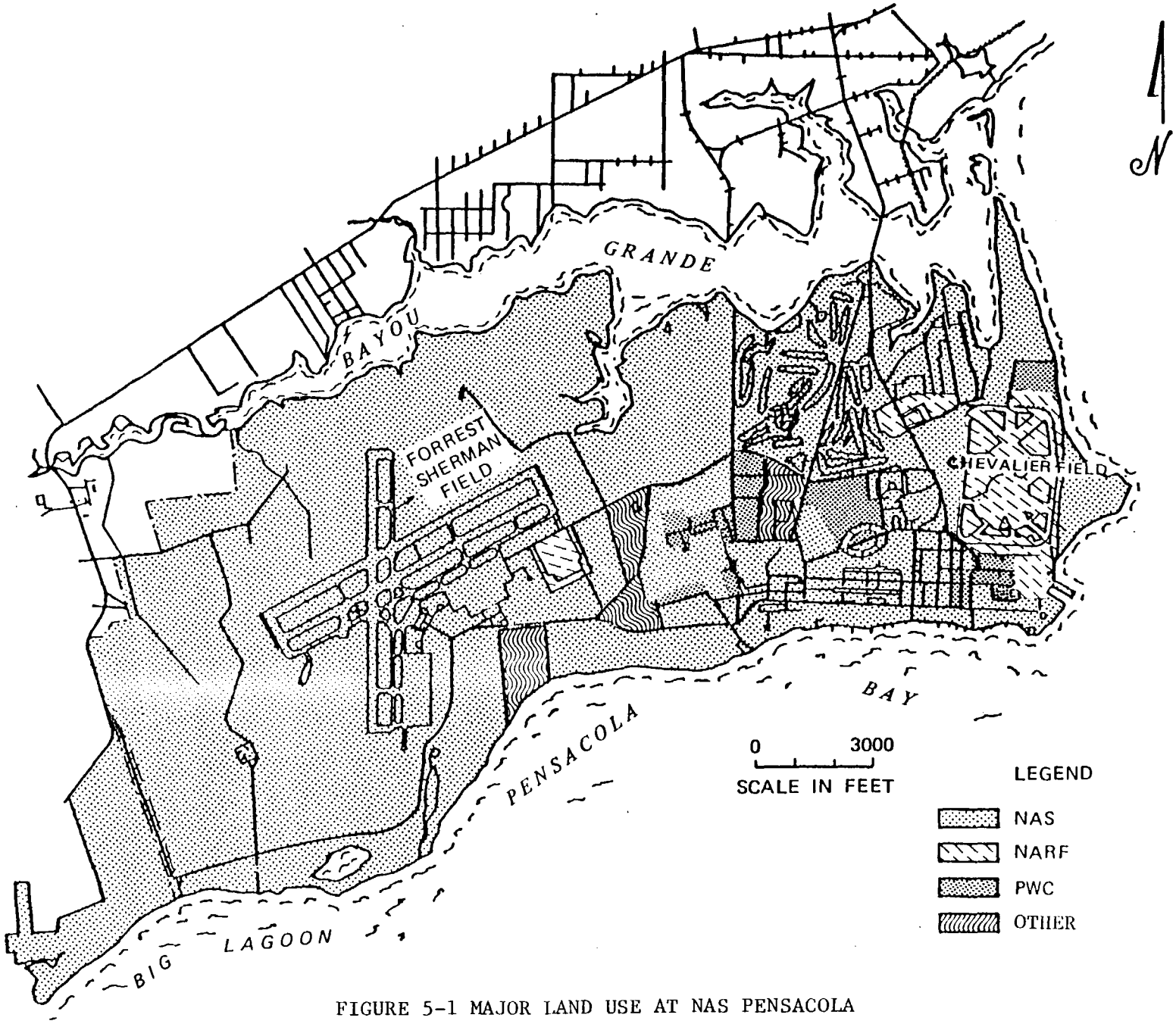
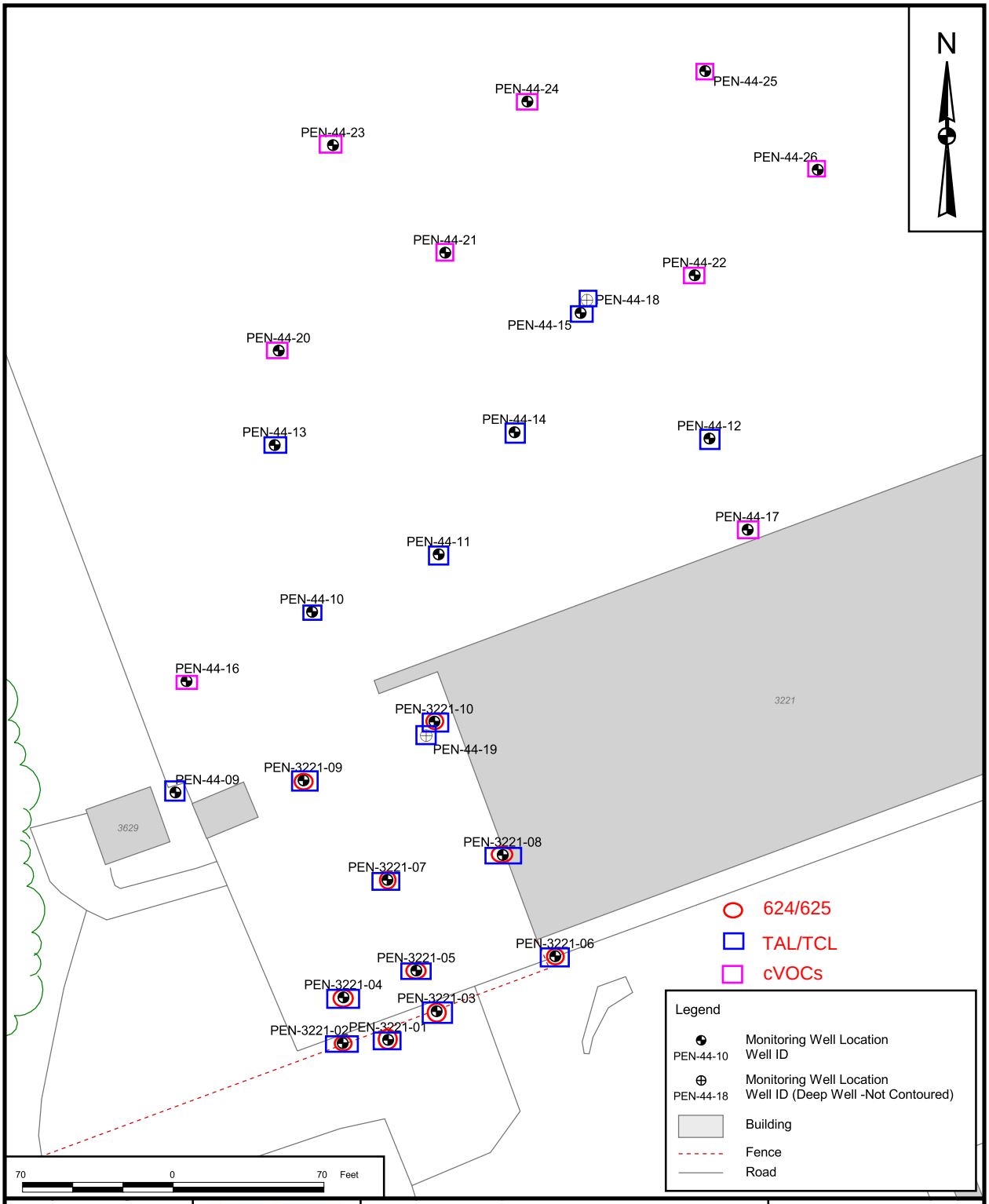


FIGURE 5-1 MAJOR LAND USE AT NAS PENSACOLA

ATTACHMENT 7
Summary of Groundwater Sampling Events and Analytical Methods

Date	Petroleum Investigation								CERCLA Investigaion						
	January (Ja), April (Ap) and August (Au), 1992				May-94				December-05					May-06	August-06
Monitoring Well	VOCs (EPA Method 624)	SVOCs (EPA Method 625)	Metals[1] (EPA Method 200 Series)	TRPH (EPA Method 418.1)	VOCs (EPA Method 8260)	SVOCs (EPA Method 8270)	Metals[2] (EPA Method 200 Series)	TRPH (EPA Method 418.1)	EPA CLP TCL VOCs	EPA CLP TCL SVOCs	EPA CLP TCL Pest/PCB	EPA CLP TAL Inorg	TRPH (FL-PRO)	(See Notes)	EPA Method 8260B
PEN-3221SW-PZ1*	Ja	Ja	Ja	Ja											
PEN-3221SW-PZ2	Ja	Ja	Ja	Ja											
PEN-3221SW-PZ3	Ja	Ja	Ja	Ja											
PEN-3221-01	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au					X	X	X	X	X		
PEN-3221-02	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au					X	X	X	X	X		
PEN-3221-03	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au					X	X	X	X	X	Mn	
PEN-3221-04	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au					X	X	X	X	X		
PEN-3221-05	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au	Ja, Ap & Au					X	X	X	X	X		
PEN-3221-06	Au	Au	Au	Au					X	X	X	X	X		
PEN-3221-07	Au	Au	Au	Au					X	X	X	X	X		
PEN-3221-08	Au	Au	Au	Au					X	X	X	X	X		
PEN-3221-09	Au	Au	Au	Au					X	X	X	X	X		
PEN-3221-10	Au	Au	Au	Au					X	X	X	X	X		
TW-1					X	X	X	X							
PEN-44-09									X	X	X	X	X		
PEN-44-10									X	X	X	X	X		
PEN-44-11									X	X	X	X	X		
PEN-44-12									X	X	X	X	X		
PEN-44-13									X	X	X	X	X		
PEN-44-14									X	X	X	X	X	DEHP	
PEN-44-15									X	X	X	X	X	cVOCs	
PEN-44-16														cVOCs	
PEN-44-17														cVOCs	
PEN-44-18									X	X	X	X	X	Fe & Mn	
PEN-44-19									X	X	X	X	X	Fe, Mn & DEHP	
PEN-44-20														cVOCs	
PEN-44-21														cVOCs	
PEN-44-22														cVOCs	
PEN-44-23															cVOCs
PEN-44-24															cVOCs
PEN-44-25															cVOCs
PEN-44-26															cVOCs

Petroleum = Investigations per Florida Petroleum Regulations (circa 1992 to 1994)
CERCLA = Investigations per Comprehensive Environmental Response, Compensation and Liability Act Facility Investigation
* = Piezometer PEN-3221SW-PZ1 was converted to monitoring well PEN-3221-02
EPA = U.S. Evironmental Protection Agency
Metals[1] = Arsenic (EPA Method 206.2), Cadmium (EPA Method 200.7), Chromium (EPA Method 200.7)and Lead (EPA Method 239.2)
Metals[2] = Arsenic (EPA Method 206.2), Cadmium (EPA Method 213.2), Chromium (EPA Method 200.7)and Lead (EPA Method 239.2)
CLP = Contract Laboratory Program
TCL = Target Compound List
TCL VOCS = Volatile Organic Compounds by USEPA Method SW-846 8260B) and Ethylene Dibromide (EDB) (USEPA 504.1)
TCL SVOCs = Semivolatile Organic Compounds by USEPA Method SW-846 8270C/8310
TCL Pest/PCB = Pesticides and Polychlorinated Biphenyls by USEPA Method SW-846 8081/8082
TAL = Target Analyte List (Inorganics)
TAL Inorganics = USEPA Method SW 846 6010B, 9010, and 7471
TRPH = Total Recoverable Petroleum Hydrocarbons
FL-PRO = Florida Petroleum Residual Organics
cVOC = Chlorinated Volatile Organic Compounds (USEPA Method 8260B)
DEHP = Bis(2-Ethyhexyl)Phthalate (USEPA Method 8270C)
Mn = Manganese (USEPA 6010B)



DRAWN BY	DATE			CONTRACT NUMBER
C. SPEHAR	1/20/06		MONITORING WELL LOCATIONS	CTO 0367
CHECKED BY	DATE		SITE 44 RI REPORT	APPROVED BY / DATE
B. OLSON	5/03/07		NAS PENSACOLA	— / —
COST/SCHEDULE-AREA			PENSACOLA, FLORIDA	APPROVED BY / DATE
				— / —
SCALE				DRAWING NO. / REV
AS NOTED				FIGURE 2-2 / 0

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR SITE 44 MW LOCATION LAYOUT 5/03/07 JEE

Environmental Analytical Chemistry

for
People who don't really care

by
Those who do

Eighth Edition
August 2005

ENVIRONMENTAL CONSERVATION LABORATORIES, INC.

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1015 Passport Way • Cary, North Carolina 27513
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EPA Method 624/8260, cont.

Component	Available Component Lists							
	624	8260	TTO	PP	TCL	App. I	App. II	App. IX
1,1,1,2-Tetrachloroethane		X				X	X	X
1,1,1-Trichloroethane	X	X	X	X	X	X	X	X
1,1,2,2-Tetrachloroethane	X	X	X	X	X	X	X	X
1,1,2-Trichloroethane	X	X	X	X	X	X	X	X
1,1-Dichloroethane	X	X	X	X	X	X	X	X
1,1-Dichloroethene	X	X	X	X	X	X	X	X
1,1-Dichloropropene		X					X	
1,2,3-Trichlorobenzene		X						
1,2,3-Trichloropropane		X				X	X	X
1,2,4-Trichlorobenzene		X					X	X
1,2,4-Trimethylbenzene		X						
1,2-Dibromo-3-chloropropane		X				X	X	X
1,2-Dibromoethane (EDB)		X				X	X	X
1,2-Dichlorobenzene	X	X	X	X		X	X	X
1,2-Dichloroethane	X	X	X	X	X	X	X	X
1,2-Dichloroethene (total)					X			
1,2-Dichloropropane	X	X	X	X	X	X	X	X
1,3,5-Trimethylbenzene		X						
1,3-Dichlorobenzene	X	X	X	X			X	X
1,3-Dichloropropane		X					X	
1,4-Dichlorobenzene	X	X	X	X		X	X	X
1,4-Dioxane								X
2,2-Dichloropropane		X					X	
2-Butanone		X			X	X	X	X
2-Chloroethyl vinyl ether	X	X	X	X				
2-Chlorotoluene		X						
2-Hexanone		X			X	X	X	X
2-Picoline								X
4-Chlorotoluene		X						
4-Methyl-2-pentanone		X			X	X	X	X
Acetone		X			X	X	X	X
Acetonitrile							X	X
Acrolein	X		X	X			X	X
Acrylonitrile	X		X	X		X	X	X
Allyl Chloride							X	X
Benzene	X	X	X	X	X	X	X	X
Bromobenzene		X						
Bromochloromethane		X				X	X	
Bromodichloromethane	X	X	X	X	X	X	X	X

EPA Method 624/8260, cont.

Component	Available Component Lists							
	624	8260	TTO	PP	TCL	App. I	App. II	App. IX
Bromoform	X	X	X		X	X	X	X
Bromomethane	X	X	X	X	X	X	X	X
Carbon Disulfide					X	X	X	X
Carbon tetrachloride	X	X	X	X	X	X	X	X
Chlorobenzene	X	X	X	X	X	X	X	X
Chloroethane	X	X	X	X	X	X	X	X
Chloroform	X	X	X	X	X	X	X	X
Chloromethane	X	X	X	X	X	X	X	X
Chloroprene							X	X
cis-1,2-Dichloroethene		X				X	X	
cis-1,3-Dichloropropene	X	X	X	X	X	X	X	X
Dibromochloromethane	X	X	X	X	X	X	X	X
Dibromomethane		X				X	X	X
Dichlorodifluoromethane	X	X	X				X	X
Ethyl Methacrylate							X	X
Ethylbenzene	X	X	X	X	X	X	X	X
Hexachlorobutadiene		X					X	X
Iodomethane						X	X	X
Isobutyl Alcohol							X	X
Isopropylbenzene		X						
Methacrylonitrile							X	X
Methyl Methacrylate							X	X
Methylene chloride	X	X	X	X	X	X	X	X
Methyl-tert-butyl ether	X	X	X					
m-Xylene & p-Xylene	X	X	X					
Naphthalene		X					X	X
n-Butylbenzene		X						
n-Propylbenzene		X						
o-Xylene	X	X	X					
Pentachloroethane								X
p-Isopropyltoluene		X						
Propionitrile							X	X
sec-Butylbenzene		X						
Styrene	X	X	X		X	X	X	X
tert-Butylbenzene		X						
Tetrachloroethene	X	X	X	X	X	X	X	X
Toluene	X	X	X	X	X	X	X	X
trans-1,2-Dichloroethene	X	X	X	X		X	X	X
trans-1,3-Dichloropropene	X	X	X		X	X	X	X

EPA Method 624/8260, cont.

Component	Available Component Lists							
	624	8260	TTO	PP	TCL	App. I	App. II	App. IX
trans-1,4-Dichloro-2-butene						X	X	X
Trichloroethene	X	X	X	X	X	X	X	X
Trichlorofluoromethane	X	X	X			X	X	X
Vinyl Acetate						X	X	X
Vinyl chloride	X	X	X	X	X	X	X	X
Xylenes (total)					X	X	X	X

EPA Method 625/8270 BASE/NEUTRAL/ACID EXTRACTABLE ORGANICS, cont.

Component	Available Component Lists						
	625	8270	TTO	PP	TCL	App. II	App. IX
1,2,4,5-Tetrachlorobenzene						X	X
1,2,4-Trichlorobenzene	X	X	X	X	X		X
1,2-Dichlorobenzene	X	X	X	X	X		X
1,3,5-Trinitrobenzene						X	X
1,3-Dichlorobenzene	X	X	X	X	X		X
1,3-Dinitrobenzene						X	X
1,4-Dichlorobenzene	X	X	X	X	X		X
1,4-Dioxane		*					X
1,4-Naphthoquinone						X	X
1-Methylnaphthalene	X	X	X				
1-Naphthylamine						X	X
2,3,4,6-Tetrachlorophenol						X	X
2,3,7,8-TCDD (presence/absence)			X				
2,4,5-Trichlorophenol		X			X	X	X
2,4,6-Trichlorophenol	X	X		X	X	X	X
2,4-Dichlorophenol	X	X	X	X	X	X	X
2,4-Dimethylphenol	X	X	X	X	X	X	X
2,4-Dinitrophenol	X	X	X	X	X	X	X
2,4-Dinitrotoluene	X	X	X	X	X	X	X
2,6-Dichlorophenol						X	X
2,6-Dinitrotoluene	X	X	X	X	X	X	X
2-Acetylaminofluorene						X	X
2-Chloronaphthalene	X	X		X	X	X	X
2-Chlorophenol	X	X	X	X	X	X	X
2-Methyl-4,6-dinitrophenol	X	X	X	X	X	X	X
2-Methylnaphthalene	X	X	X		X	X	X
2-Methylphenol		X			X	X	
2-Naphthylamine						X	X
2-Nitroaniline		X			X	X	X
2-Nitrophenol	X	X	X	X	X	X	X
2-Picoline							X
3,3'-Dimethylbenzidine						X	X
3,3'-Dichlorobenzidine	X	X	X		X	X	X
3-Methylcholanthrene						X	X
3-Methylphenol		X				X	X
3-Nitroaniline		X			X	X	X

EPA Method 625/8270 BASE/NEUTRAL/ACID EXTRACTABLE ORGANICS, cont.

Component	Available Component Lists						
	625	8270	TTO	PP	TCL	App. II	App. IX
4-Aminobiphenyl						X	X
4-Bromophenyl phenyl ether	X	X		X	X	X	X
4-Chloro-3-methyl phenol	X	X	X	X	X	X	X
4-Chloroaniline		X			X	X	X
4-Chlorophenylphenyl ether	X	X		X	X	X	X
4-Methylphenol		X			X	X	X
4-Nitroaniline		X			X	X	X
4-Nitrophenol	X	X	X	X	X	X	X
4-Nitroquinoline 1-oxide							X
5-Nitro-o-toluidine						X	X
7,12-Dimethyl benz[a]anthracene						X	X
a,a-Dimethylphenethylamine							X
Acenaphthene	X	X	X	X	X	X	X
Acenaphthylene	X	X	X	X	X	X	X
Acetophenone						X	X
Aniline							X
Anthracene	X	X	X	X	X	X	X
Aramite							X
Benzidine	X	X	X	X			
Benzo(a)anthracene	X	X	X	X	X	X	X
Benzo(a)pyrene	X	X	X	X	X	X	X
Benzo(b)fluoranthene	X	X	X	X	X	X	X
Benzo(g,h,i)perylene	X	X	X	X	X	X	X
Benzo(k)fluoranthene	X	X	X	X	X	X	X
Benzoic acid		X					
Benzyl alcohol		X				X	X
Benzyl-butylphthalate	X	X	X	X	X	X	X
Bis(2-chloroethoxy) methane	X	X	X	X	X	X	X
Bis(2-chloroethyl) ether	X	X	X	X	X	X	X
Bis(2-chloro-isopropyl) ether	X	X	X	X	X	X	X
Bis(2-ethylhexyl) phthalate	X	X	X	X	X	X	X
Carbazole					X		
Chrysene	X	X	X	X	X	X	X
Diallate							X
Dibenzo(a,h) anthracene	X	X	X	X	X	X	X

EPA Method 625/8270 BASE/NEUTRAL/ACID EXTRACTABLE ORGANICS, cont.

Component	Available Component Lists						
	625	8270	TTO	PP	TCL	App. II	App. IX
Dibenzofuran		X			X	X	X
Diethyl phthalate	X	X	X	X	X	X	X
Dimethyl phthalate	X	X	X	X	X	X	X
Di-n-butyl phthalate	X	X	X	X	X	X	X
Di-n-octyl phthalate	X	X	X	X	X	X	X
Dinoseb							X
Diphenylamine						X	X
Ethyl Methanesulfonate						X	X
p-(dimethylamino) azobenzene	X	X	X			X	X
Fluoranthene	X	X	X	X	X	X	X
Fluorene	X	X	X	X	X	X	X
Hexachlorobenzene	X	X	X	X	X	X	X
Hexachlorobutadiene	X	X	X	X	X	X	X
Hexachlorocyclopentadiene	X	X	X	X	X	X	X
Hexachloroethane	X	X	X	X	X	X	X
Hexachlorophene							X
Hexachloropropene						X	X
Indeno (1,2,3-c,d)pyrene	X	X	X	X	X	X	X
Isophorone	X	X	X	X	X	X	X
Isosafrole						X	X
Methapyrilene						X	X
Methyl Methanesulfonate						X	X
Naphthalene	X	X	X	X	X		X
Nitrobenzene	X	X	X	X	X	X	X
N-Nitrosodiethylamine						X	X
N-Nitrosodimethylamine	X	X	X	X		X	X
N-Nitrosodi-n-butyl amine						X	X
N-Nitrosodi-n-propyl amine	X	X	X	X	X	X	X
N-Nitrosodiphenylamine	X	X	X	X	X	X	X
N-Nitrosomethylethylamine						X	X
N-Nitrosomorpholine							X
N-Nitrosopiperidine						X	X
N-Nitrosopyrrolidine						X	X
O,O,O-Triethyl phosphorothioate						X	X
o-Toluidine						X	X

EPA Method 625/8270 BASE/NEUTRAL/ACID EXTRACTABLE ORGANICS, cont.

Component	Available Component Lists						
	625	8270	TTO	PP	TCL	App. II	App. IX
Pentachlorobenzene						X	X
Pentachloronitrobenzene						X	X
Pentachlorophenol	X	X	X	X	X	X	X
Phenacetin						X	X
Phenanthrene	X	X	X	X	X	X	X
Phenol	X	X	X	X	X	X	X
p-Phenylenediamine						X	X
Pronamide						X	X
Pyrene	X	X	X	X	X	X	X
Pyridine		X					X
Safrole						X	X

*ENCO has developed a method using 8270 to analyze for 1,4-dioxane to approach the new Florida Groundwater Cleanup Target Level.

EPA Method 608/8081/8082, cont.

Component	608	8081	8082	TCL	PP	TTO	App. II	App. IX
α-BHC (alpha)	X	X		X	X	X	X	X
β-BHC (beta)	X	X		X	X	X	X	X
δ-BHC (delta)	X	X		X	X	X	X	X
γ-BHC (Lindane) (gamma)	X	X		X	X	X	X	X
4,4'-DDD	X	X		X	X	X	X	X
4,4'-DDE	X	X		X	X	X	X	X
4,4'-DDT	X	X		X	X	X	X	X
Aldrin	X	X		X	X	X	X	X
Chlordane (Tech. Grade)	X	X			X	X	X	X
α-Chlordane (alpha)		X		X			X	
γ-Chlordane (gamma)		X		X			X	
Chlorobenzilate		X						X
Diallate		X						
Dieldrin	X	X		X	X	X	X	X
Endosulfan I	X	X		X	X	X	X	X
Endosulfan II	X	X		X	X	X	X	X
Endosulfan sulfate	X	X		X	X	X	X	X
Endrin	X	X		X	X	X	X	X
Endrin Aldehyde	X	X		X	X	X	X	X
Endrin Ketone		X		X				
Heptachlor	X	X		X	X	X	X	X
Heptachlor epoxide	X	X		X	X	X	X	X
Hep. Epox. (α Isomer)		X						
Hep. Epox. (β Isomer)		X						
Isodrin		X					X	X
Kepone		X					X	
Methoxychlor	X	X		X			X	X
Mirex		X						
PCB-1016	X		X	X	X	X	X	X
PCB-1221	X		X	X	X	X	X	X
PCB-1232	X		X	X	X	X	X	X
PCB-1242	X		X	X	X	X	X	X
PCB-1248	X		X	X	X	X	X	X
PCB-1254	X		X	X	X	X	X	X
PCB-1260	X		X	X	X	X	X	X
Toxaphene	X	X		X	X	X	X	X

E. Inorganic Lists

Element	RCRA	PP	TAL	Appx. I	Appx. II	Appx. IX
Aluminum, Al			X			
Antimony, Sb		X	X	X	X	X
Arsenic, As	X	X	X	X	X	X
Barium, Ba	X		X	X	X	X
Beryllium, Be		X	X	X	X	X
Boron						
Cadmium, Cd	X	X	X	X	X	X
Calcium, Ca			X			
Chromium, Cr	X	X	X	X	X	X
Cobalt, Co			X	X	X	X
Copper, Cu		X	X	X	X	X
Iron, Fe			X			
Lead, Pb	X	X	X	X	X	X
Magnesium, Mg			X			
Manganese, Mn			X			
Mercury, Hg	X	X	X		X	X
Molybdenum, Mo						
Nickel, Ni		X	X	X	X	X
Potassium, K			X			
Selenium Se	X	X	X	X	X	X
Silver, Ag	X	X	X	X	X	X
Sodium, Na			X			
Thallium, Tl		X	X	X	X	X
Tin, Sn					X	X
Vanadium, V			X	X	X	X
Zinc, Zn		X	X	X	X	X

RCRA: Resource Conservation & Recovery Act
PP: Priority Pollutant
TAL: Target Analyte List

TRPH, EPA Method 418.1/SW-846 Method 9073
Total Recoverable Petroleum Hydrocarbons

METHOD SUMMARY: A 1 liter water sample or 30 g soil sample is acidified and serially extracted with fluorocarbon-113 (Freon). Silica gel is added to the extract to remove polar materials leaving only the nonpolar petroleum hydrocarbons. The concentration of TRPH present is measured via infrared spectroscopy.

DETECTION LEVEL: 1 mg/L – water, 5 mg/Kg - soil

SAMPLING: A representative sample of water or soil should be collected in a glass bottle. Because losses will occur on sampling equipment, the collection of a composite sample is impractical.

PRESERVATIVE: Refrigerate at 4 °C, add H_2SO_4 to pH < 2 for aqueous samples. Refrigerate at 4 °C for soils.

HOLDING TIMES: 28 days

COMMENTS:
As in the case of oil & grease, the parameter "petroleum hydrocarbons" is defined by the method based upon solubility in freon-113. The measurement may be subject to interferences and the results should be evaluated accordingly. Oil and grease is a measure of biodegradable animal greases and vegetable oils along with the relative non-biodegradable mineral oils. Total Recoverable Petroleum Hydrocarbons is the measure of only the mineral oils. Maximum information may be obtained using both methods to measure and characterize oil and grease of all sources.

This method is not applicable to the measurement of light hydrocarbons that volatilize at temperatures below 70 °C (the concentration bath temperature). Petroleum fuels from gasoline through #2 fuel oils are completely or partially lost in the solvent removal operation. Some crude oils and heavy fuel oils contain a significant percentage of residue-type materials that are not soluble in fluorocarbon-113. Accordingly, recoveries of these materials will be low.

Due to increasing pressures to eliminate the uses of chlorofluorocarbons, the EPA has developed an alternative procedure (EPA Method 1664a - Silica Gel Treated Hexane Extractable Material). This procedure does yield different concentrations versus the Freon based methods, and this variation can result in higher or lower results.

Additionally, many states have adopted GC-based TPH analyses such as the FL-PRO, GRO, and DRO to further eliminate the use of Freon.

PREFERRED SAMPLING CONTAINER: 2x1liter amber glass jar with Teflon lined lid for liquid samples and 500 mL amber glass jar with Teflon lined lid for soil samples.

Florida Method FL-PRO
Petroleum Range Organics

Total Petroleum Hydrocarbons within the alkane range of C8–C40.

METHOD SUMMARY: A 1 liter water sample or 30 g soil sample is extracted with methylene chloride, dried and concentrated to 10 mL or less. The extract is subjected to a silica gel cleanup to remove any aliphatic hydrocarbons present, then analyzed using a gas chromatograph equipped with a flame ionization detector (FID).

DETECTION LEVEL: 0.2 mg/L (aqueous) or 6.0 mg/Kg (Solids)

SAMPLING: Samples must be collected in glass container. DO NOT rinse the bottle with sample prior to filling.

PRESERVATIVE: Neutralize any residual chlorine present with 80 mg of sodium thiosulfate per liter. Aqueous samples are preserved to a pH of less than 2 with sulfuric acid. Samples should be kept on ice from time of sampling to extraction.

HOLDING TIMES: Aqueous samples must be extracted within 7 days, soil samples must be extracted within 14 days, and all extracts must be analyzed within 40 days of extraction.

COMMENTS: This method was developed by the Florida Department of Environmental Protection to replace the freon-based procedures 418.1 and 9073 for all petroleum-related work (procedures required by FL Administrative Codes 62-770 and 62-775).

The method was developed to quantify total response from C8 (midpoint of most gasolines) through C40 (heavier than most motor oils). Results cannot be compared between the freon-based procedures and the FL-PRO due to differences in the solvents' solubility characteristics and the temperature limitations associated with GC analyses.

PREFERRED SAMPLING CONTAINER: 2 x 1-L amber glass bottle for aqueous samples, 1x4 oz glass jar for solids.

ATTACHMENT 8
Comparison of Analytical Methods and Analytes

USEPA TARGET COMPOUND LIST VOLATILES (Current)	Trace Water MDL (µg/L)	Low Water MDL (µg/L)	USEPA TARGET COMPOUND LIST VOLATILES (2005-2006)	MDL (µg/L)	USEPA METHOD 624 (1992)	MDL (µg/L)
					Acrolein	10
					Acrylonitrile	10
Acetone	5	10	Acetone	2		
Benzene	0.5	5	Benzene	0.3	Benzene	
Bromochloromethane	0.5	5	Bromochloromethane	0.2		1
Bromodichloromethane	0.5	5			Bromodichloromethane	1
Bromoform	0.5	5	Bromoform	0.5	Bromoform	1
Bromomethane	0.5	5	Bromomethane	0.6	Bromomethane	1
Carbon disulfide	0.5	5	Carbon disulfide	0.3		
Carbon tetrachloride	0.5	5	Carbon tetrachloride	0.3	Carbon tetrachloride	1
Chlorobenzene	0.5	5	Chlorobenzene	0.2	Chlorobenzene	1
Chloroethane	0.5	5	Chloroethane	0.3	Chloroethane	1
Chloroform	0.5	5	Chloroform	0.4	Chloroform	1
Chloromethane	0.5	5	Chloromethane	0.3	Chloromethane	1
cis-1,2-Dichloroethene	0.5	5	cis-1,2-Dichloroethene	0.3		
cis-1,3-Dichloropropene	0.5	5	cis-1,3-Dichloropropene	0.3	cis-1,3-Dichloropropene	1
Cyclohexane	0.5	5				
Dibromochloromethane	0.5	5	Chlorodibromomethane	0.4	Chlorodibromomethane	1
Dichlorodifluoromethane	0.5	5				
Ethylbenzene	0.5	5	Ethylbenzene	0.2	Ethylbenzene	1
Isopropylbenzene	0.5	5				
m,p-Xylene	0.5	5	m,p-Xylene	0.5		
Methyl acetate	0.5	5				
Methyl tert-butyl ether	0.5	5				
Methylcyclohexane	0.5	5				
Methylene chloride	0.5	5	Methylene chloride	2	Methylene chloride	1

USEPA TARGET COMPOUND LIST VOLATILES (Current)	Trace Water MDL (µg/L)	Low Water MDL (µg/L)	USEPA TARGET COMPOUND LIST VOLATILES (2005-2006)	MDL (µg/L)	USEPA METHOD 624 (1992)	MDL (µg/L)
o-Xylene	0.5	5	o-Xylene	0.3		
Styrene	0.5	5	Styrene	0.6		
Tetrachloroethene	0.5	5	Tetrachloroethene	0.4	Tetrachloroethene	1
Toluene	0.5	5	Toluene	0.2	Toluene	1
			Total-1,2-Dichloroethene	0.6		
trans-1,2-Dichloroethene	0.5	5	trans-1,2-Dichloroethene	0.3	trans-1,2-Dichloroethene	1
			Xylenes (total)	0.8	Xylenes (total)	1
trans-1,3-Dichloropropene	0.5	5	trans-1,3-Dichloropropene	0.4	trans-1,3-Dichloropropene	1
Trichloroethene	0.5	5	Trichloroethene	0.3	Trichloroethene	1
Trichlorofluoromethane	0.5	5			Trichlorofluoromethane	1
Vinyl chloride	0.5	5	Vinyl chloride	0.3	Vinyl chloride	1
1,1,1-Trichloroethane	0.5	5	1,1,1-Trichloroethane	0.2	1,1,1-Trichloroethane	1
1,1,2,2-Tetrachloroethane	0.5	5	1,1,2,2-Tetrachloroethane	0.5	1,1,2,2-Tetrachloroethane	1
1,1,2-Trichloro-1,2,2-trifluoroethane	0.5	5				
1,1,2-Trichloroethane	0.5	5	1,1,2-Trichloroethane	0.3	1,1,2-Trichloroethane	1
1,1-Dichloroethane	0.5	5	1,1-Dichloroethane	0.4	1,1-Dichloroethane	1
1,1-Dichloroethene	0.5	5	1,1-Dichloroethene	0.4	1,1-Dichloroethene	1
					1,2-Dichlorobenzene	1
1,2,3-Trichlorobenzene	0.5	5				
1,2,4-Trichlorobenzene	0.5	5				
1,2-Dibromo-3-chloropropane	0.5	5				
1,2-Dibromoethane	0.5	5	1,2-Dibromoethane	0.0051		
1,2-Dichlorobenzene	0.5	5				
1,2-Dichloroethane	0.5	5	1,2-Dichloroethane	0.3	1,2-Dichloroethane	1
1,2-Dichloropropane	0.5	5	1,2-Dichloropropane	0.3	1,2-Dichloropropane	1

USEPA TARGET COMPOUND LIST VOLATILES (Current)	Trace Water MDL (µg/L)	Low Water MDL (µg/L)	USEPA TARGET COMPOUND LIST VOLATILES (2005-2006)	MDL (µg/L)	USEPA METHOD 624 (1992)	MDL (µg/L)
1,3-Dichlorobenzene	0.5	5			1,3-Dichlorobenzene	1
1,4-Dichlorobenzene	0.5	100			1,4-Dichlorobenzene	1
1,4-Dioxane		10				
					2-Chloroethyl vinyl ether	1
2-Butanone	5	10	2-Butanone	3		
2-Hexanone	5	10	2-Hexanone	2		
4-Methyl-2-pentanone	5	10	4-Methyl-2-pentanone	3		

Notes:
USEPA = U.S. Environmental Protection Agency
µg/L = micrograms per liter
MDL = method detection limit

USEPA TARGET COMPOUND LIST SEMIVOLATILES (Current)	Trace Water MDL (µg/L)	Low Water MDL (µg/L)	USEPA TARGET COMPOUND LIST SEMIVOLATILES (2005-2006)	MDL (µg/L)	USEPA METHOD 625 (1992)	MDL (µg/L)
Acenaphthene	0.1	5	Acenaphthene	0.09	Acenaphthene	10
Acenaphthylene	0.1	5	Acenaphthylene	0.04	Acenaphthylene	10
Acetophenone		5				
Anthracene	0.1	5	Anthracene	0.07	Anthracene	10
					Benzidine	50
Atrazine		5				
Benzaldehyde		5				
Benzo(a) pyrene	0.1	5	Benzo(a) pyrene	0.08	Benzo(a) pyrene	10
Benzo(a)anthracene	0.1	5	Benzo(a)anthracene	0.08	Benzo(a)anthracene	10
Benzo(b) fluoranthene	0.1	5	Benzo(b) fluoranthene	0.08	Benzo(b) fluoranthene	10
Benzo(g,h,i) perylene	0.1	5	Benzo(g,h,i) perylene	0.1	Benzo(g,h,i) perylene	10
Benzo(k) fluoranthene	0.1	5	Benzo(k) fluoranthene	0.09	Benzo(k) fluoranthene	10
Bis(2-chloroethoxy) methane		5	Bis(2-chloroethoxy) methane	3	Bis(2-chloroethoxy) methane	10
Bis(2-chloroethyl) ether		5	Bis(2-chloroethyl) ether	3	Bis(2-chloroethyl) ether	10
					Bis(2-chloroisopropyl)ether	10
Bis(2-ethylhexyl) phthalate		5	Bis(2-ethylhexyl) phthalate	7	Bis(2-ethylhexyl) phthalate	10
Butylbenzylphthalate		5	Butylbenzylphthalate	3	Butylbenzylphthalate	10
Caprolactam		5				
Carbazole		5	Carbazole	4		
Chrysene	0.1	5	Chrysene	0.05	Chrysene	10
Dibenzo(a,h) anthracene	0.1	5	Dibenzo(a,h) anthracene	0.1	Dibenzo(a,h) anthracene	10
Dibenzofuran		5	Dibenzofuran	3		
Diethylphthalate		5	Diethylphthalate	2	Diethylphthalate	10
Dimethylphthalate		5	Dimethylphthalate	3	Dimethylphthalate	10
Di-n-butylphthalate		5	Di-n-butylphthalate	2	Di-n-butylphthalate	10
Di-n-octylphthalate		5	Di-n-octylphthalate	3	Di-n-octylphthalate	10
Fluoranthene	0.1	5	Fluoranthene	0.07	Fluoranthene	10

USEPA TARGET COMPOUND LIST SEMIVOLATILES (Current)	Trace Water MDL (µg/L)	Low Water MDL (µg/L)	USEPA TARGET COMPOUND LIST SEMIVOLATILES (2005-2006)	MDL (µg/L)	USEPA METHOD 625 (1992)	MDL (µg/L)
Fluorene	0.1	5	Fluorene	0.06	Fluorene	10
Hexachlorobenzene		5	Hexachlorobenzene	4	Hexachlorobenzene	10
Hexachlorobutadiene		5	Hexachlorobutadiene	4	Hexachlorobutadiene	10
Hexachlorocyclopentadiene		5	Hexachlorocyclopentadiene	2	Hexachlorocyclopentadiene	10
Hexachloroethane		5	Hexachloroethane	2	Hexachloroethane	10
Indeno(1,2,3,-cd) pyrene	0.1	5	Indeno(1,2,3,-cd) pyrene	0.07	Indeno(1,2,3,-cd) pyrene	10
Isophorone		5	Isophorone	2	Isophorone	10
Naphthalene	0.1	5	Naphthalene	0.05	Naphthalene	10
Nitrobenzene		5	Nitrobenzene	2	Nitrobenzene	10
					n-Nitrosodimethylamine	10
N-Nitroso-di-n propylamine		5	N-Nitroso-di-n propylamine	2	N-Nitroso-di-n propylamine	10
N-Nitrosodiphenylamine		5	N-Nitrosodiphenylamine	8	N-Nitrosodiphenylamine	10
Pentachlorophenol	0.2	10	Pentachlorophenol	9	Pentachlorophenol	50
Phenanthrene	0.1	5	Phenanthrene	0.08	Phenanthrene	10
Phenol		5	Phenol	6	Phenol	10
Pyrene	0.1	5	Pyrene	0.08	Pyrene	10
			1,2,4-Trichlorobenzene	3	1,2,4-Trichlorobenzene	10
			1,2-Dichlorobenzene	3	1,2-Dichlorobenzene	10
			1,3-Dichlorobenzene	3	1,3-Dichlorobenzene	10
			1,4-Dichlorobenzene	3	1,4-Dichlorobenzene	10
			2,2'-Oxybis(1-chloropropane)	2		
1,1'-Biphenyl		5				
1,2,4,5-Tetrachlorobenzene		5				
2,2'-Oxybis(1-choloropropane)		5				
2,3,4,6-Tetrachlorophenol		5				
2,4,5-Trichlorophenol		5	2,4,5-Trichlorophenol	7		
2,4,6-Trichlorophenol		5	2,4,6-Trichlorophenol	7	2,4,6-Trichlorophenol	10

USEPA TARGET COMPOUND LIST SEMIVOLATILES (Current)	Trace Water MDL (µg/L)	Low Water MDL (µg/L)	USEPA TARGET COMPOUND LIST SEMIVOLATILES (2005-2006)	MDL (µg/L)	USEPA METHOD 625 (1992)	MDL (µg/L)
2,4-Dichlorophenol		5	2,4-Dichlorophenol	6	2,4-Dichlorophenol	10
2,4-Dimethylphenol		5	2,4-Dimethylphenol	7	2,4-Dimethylphenol	10
2,4-Dinitrophenol		10	2,4-Dinitrophenol	5	2,4-Dinitrophenol	50
2,4-Dinitrotoluene		5	2,4-Dinitrotoluene	4	2,4-Dinitrotoluene	10
2,6-Dinitrotoluene		5	2,6-Dinitrotoluene	3	2,6-Dinitrotoluene	10
2-Chloronaphthalene		5	2-Chloronaphthalene	3	2-Chloronaphthalene	10
2-Chlorophenol		5	2-Chlorophenol	5	2-Chlorophenol	10
2-Methylnaphthalene	0.1	5	2-Methylnaphthalene	0.06		
2-Methylphenol		5	2-Methylphenol	5		
2-Nitroaniline		10	2-Nitroaniline	3		
2-Nitrophenol		5	2-Nitrophenol	5	2-Nitrophenol	
3,3'-Dicholorobenzidine		5	3,3'-Dicholorobenzidine	4	3,3'-Dicholorobenzidine	50
3-Nitroaniline		10	3-Nitroaniline	3		
4,6-Dinitro-2-methylphenol		10	4,6-Dinitro-2-methylphenol	10	4,6-Dinitro-2-methylphenol	50
4-Bromophenyl-phenylether		5	4-Bromophenyl-phenylether	4	4-Bromophenyl-phenylether	10
4-Chloro-3-methylphenol		5	4-Chloro-3-methylphenol	6	4-Chloro-3-methylphenol	10
4-Chloroaniline		5	4-Chloroaniline	4		
4-Chlorophenyl-phenyl ether		5	4-Chlorophenyl-phenyl ether	3	4-Chlorophenyl-phenyl ether	10
4-Methylphenol		5	4-Methylphenol	5		
4-Nitroaniline		10	4-Nitroaniline	5		
4-Nitrophenol		10	4-Nitrophenol	5	4-Nitrophenol	50

Notes:
USEPA = U.S. Environmental Protection Agency
µg/L = micrograms per liter
MDL = method detection limit

USEPA TARGET COMPOUND LIST PESTICIDES/POLYCHLORINATED BIPHENYLS (Current)	Water MDL (µg/L)	USEPA TARGET COMPOUND LIST PESTICIDES/POLYCHLORINATED BIPHENYLS (2005-2006)	MDL (µg/L)
4,4'-DDD	0.1	4,4'-DDD	0.015
4,4'-DDE	0.1	4,4'-DDE	0.058
4,4'-DDT	0.1	4,4'-DDT	0.042
Aldrin	0.05	Aldrin	0.026
alpha-BHC	0.05	alpha-BHC	0.018
alpha-Chlordane	0.05	alpha-Chlordane	0.022
beta-BHC	0.05	beta-BHC	0.024
delta-BHC	0.05	delta-BHC	0.026
Dieldrin	0.1	Dieldrin	0.012
Endosulfan I	0.05	Endosulfan I	0.023
Endosulfan II	0.1	Endosulfan II	0.014
Endosulfan sulfate	0.1	Endosulfan sulfate	0.012
Endrin	0.1	Endrin	0.01
Endrin aldehyde	0.1	Endrin aldehyde	0.032
Endrin ketone	0.1	Endrin ketone	0.017
gamma-BHC (Lindane)	0.05	gamma-BHC (Lindane)	0.016
gamma-Chlordane	0.05	gamma-Chlordane	0.029
Heptachlor	0.05	Heptachlor	0.017
Heptachlor epoxide	0.05	Heptachlor epoxide	0.014
Methoxychlor	0.5	Methoxychlor	0.033
Toxaphene	5	Toxaphene	0.28
Aroclor-1016	1	Aroclor-1016	0.5
Aroclor-1221	1	Aroclor-1221	0.5
Aroclor-1232	1	Aroclor-1232	0.5
Aroclor-1242	1	Aroclor-1242	0.5
Aroclor-1248	1	Aroclor-1248	0.5
Aroclor-1254	1	Aroclor-1254	0.5
Aroclor-1260	1	Aroclor-1260	0.5
Aroclor-1262	1		
Aroclor-1268	1		

Notes:
USEPA = U.S. Environmental Protection Agency
µg/L = micrograms per liter
MDL = method detection limit

USEPA TARGET ANALYTE LIST METALS (Current)	ICP-AES Water (µg/L)	ICP-MS Water (µg/L)	USEPA TARGET ANALYTE LIST METALS (2005-2006)	MDL (µg/L)	Metals (1992)	MDL (µg/L)
Aluminum	200	20	Aluminum	2.73		
Antimony	60	2	Antimony	4.11		
Arsenic	10	1	Arsenic	3.45	Arsenic	10
Barium	200	10	Barium	1.17		
Beryllium	5	1	Beryllium	0.29		
Cadmium	5	1	Cadmium	4.36	Cadmium	10
Calcium	5000	500	Calcium	21.4		
Chromium	10	2	Chromium	1.01	Chromium	50
Cobalt	50	1	Cobalt	3.05		
Copper	25	2	Copper	2.86		
Iron	100	200	Iron	3.79		
Lead	10	1	Lead	1.65	Lead	5
Magnesium	5000	500	Magnesium	26		
Manganese	15	1	Manganese	0.7		
Mercury[1]	0.2	0.1	Mercury[1]	0.02		
Nickel	40	1	Nickel	11.7		
Potassium	5000	500	Potassium	420		
Selenium	35	5	Selenium	3.59		
Silver	10	1	Silver	4.4		
Sodium	5000	500	Sodium	33.8		
Thallium	25	1	Thallium	6.13		
Vanadium	50	5	Vanadium	4.88		
Zinc	60	2	Zinc	1.74		

Notes:
USEPA = U.S. Environmental Protection Agency
[1] = Mercury by Cold Vapor Atomic Absorption
µg/L = micrograms per liter
MDL = method detection limit
ICP-AES = inductively coupled plasma atomic emission spectroscopy
ICP-MS = inductively coupled plasma mass spectrometry

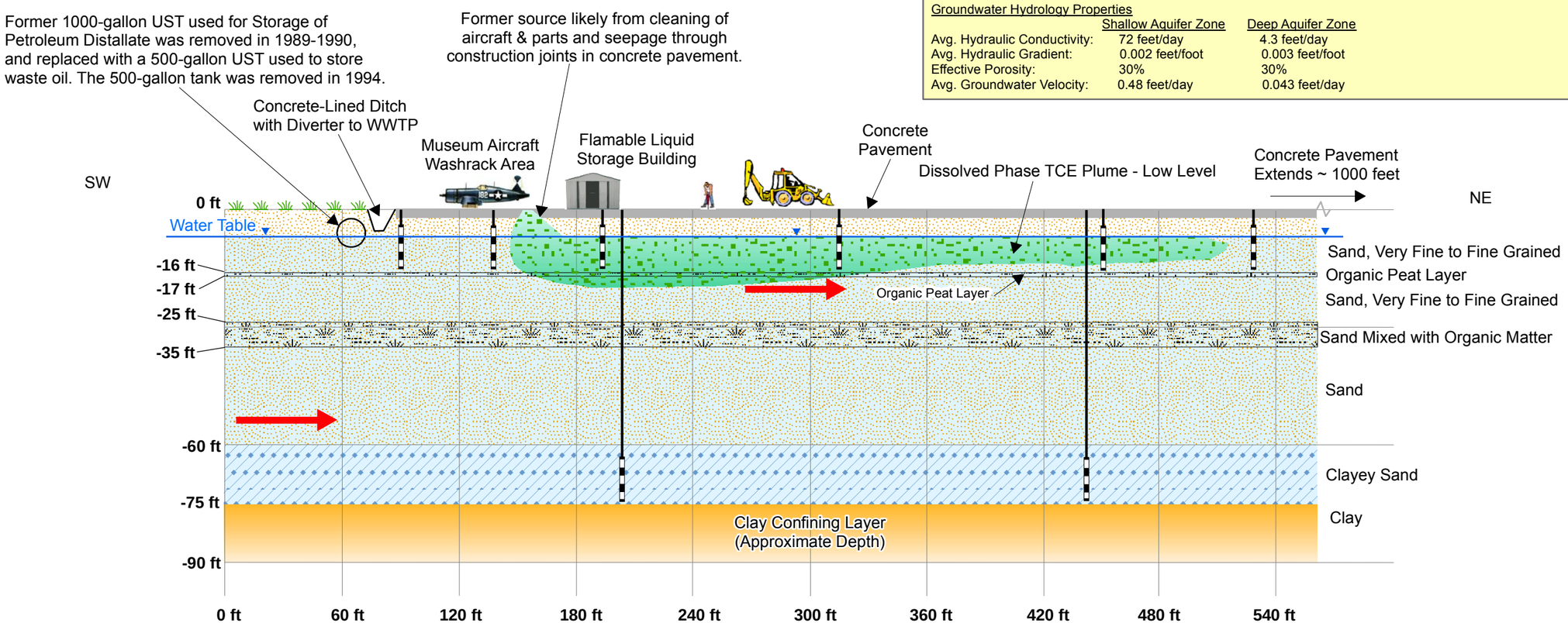
ATTACHMENT 9
Revised Figures

PGH P:\GIS\PENSACOLA_NAS\MXD\SITE44_CSM.MXD 01/31/12 JEE

NOTES:
1. In the past, Building 3221 was a hangar and adjacent paved areas were part of the Naval Air Rework Facility. These facilities were used for aircraft maintenance. Building 3221 (Figure 10-5) was evaluated as a potential historical source of groundwater contamination at Site 44. However, soil and groundwater sampling performed during the CAR and RI along the southwest side and northwest corner of the building adjacent to Site 44 indicated Building 3221 is not a source of contamination for the Site 44 groundwater contamination, (Worksheet 10.3.2).
2. The current site is used as a wash rack for cleaning aircraft and aircraft parts that are being refurbished for museum display.
3. Surface drainage in the wash rack area flows to a concrete-lined ditch and is diverted to the WWTP during aircraft washing activities.
4. Current and future land use is industrial (no residential).
5. No potable water use.
6. No ecological habitat.
7. Concrete pavement prevents exposure by site visitors and trespassers.
8. Any potential exposure for excavation/construction workers is managed by LUCs.

Groundwater Hydrology Properties

	Shallow Aquifer Zone	Deep Aquifer Zone
Avg. Hydraulic Conductivity:	72 feet/day	4.3 feet/day
Avg. Hydraulic Gradient:	0.002 feet/foot	0.003 feet/foot
Effective Porosity:	30%	30%
Avg. Groundwater Velocity:	0.48 feet/day	0.043 feet/day



Legend
- Groundwater Flow Direction
- Monitoring Well
- Monitoring Well Screen Interval

DRAWN BY	DATE
K. MOORE	04/11/11
CHECKED BY	DATE
M. MAUGHON	01/31/12
REVISED BY	DATE
J. ENGLISH	01/31/12
SCALE AS NOTED	

NAVFAC

CONCEPTUAL SITE MODEL
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
—	0079
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO. FIGURE 10-6	REV 0

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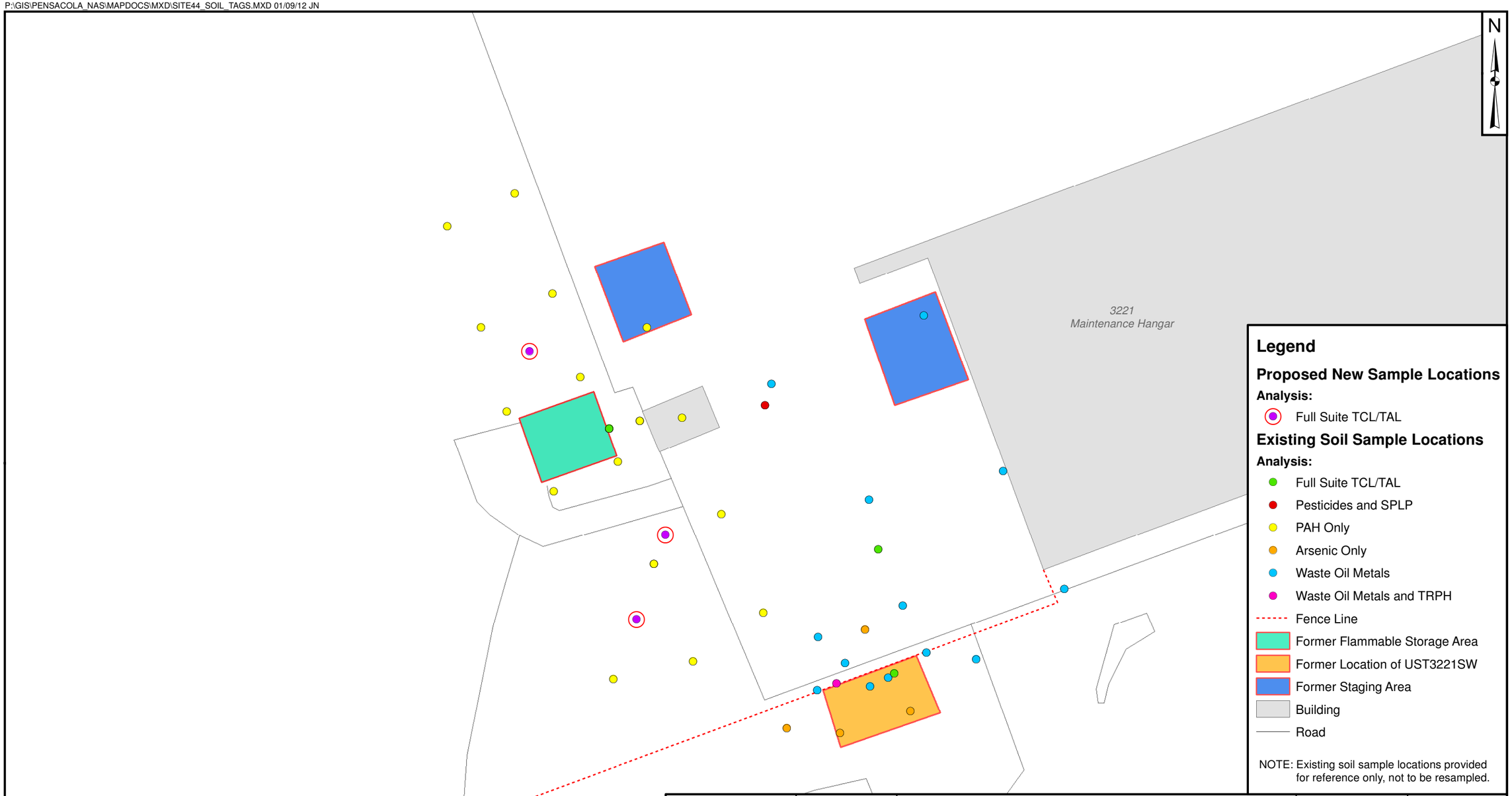

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K. MOORE	1/24/12
CHECKED BY	DATE
M. MAUGHON	1/24/12
REVISED BY	DATE
SCALE	
AS NOTED	

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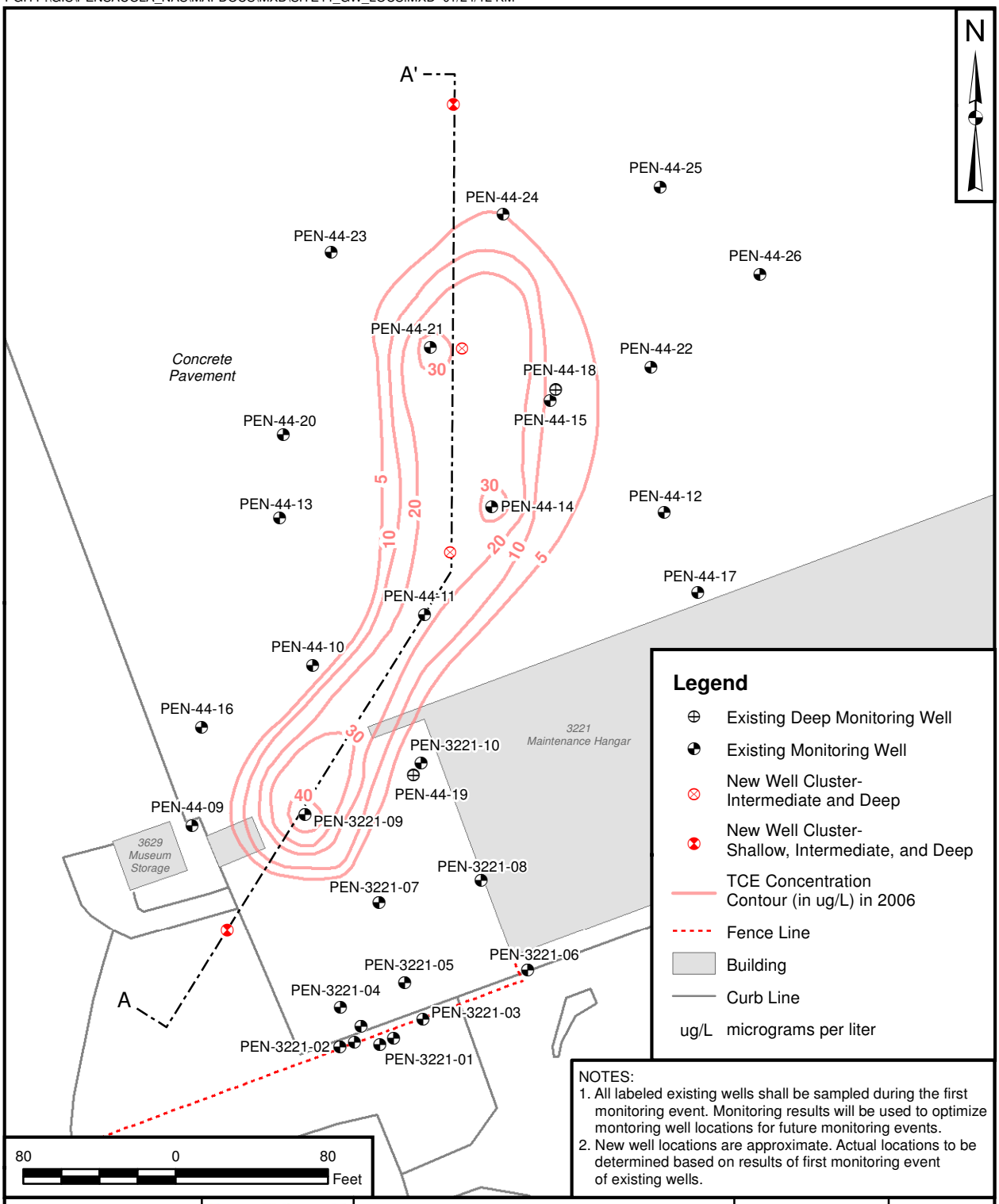
SOIL SAMPLE LOCATIONS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
	0079
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO.	REV
FIGURE 17-1	0

PGH P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE44_GW_LOCS.MXD 01/24/12 KM



NOTES:
1. All labeled existing wells shall be sampled during the first monitoring event. Monitoring results will be used to optimize montoring well locations for future monitoring events.
2. New well locations are approximate. Actual locations to be determined based on results of first monitoring event of existing wells.

DRAWN BY J. ENGLISH	DATE 12/22/10	GROUNDWATER SAMPLE LOCATIONS SITE 44 NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER ___ / CTO NUMBER 0079
CHECKED BY M. MAUGHON	DATE 01/24/11		APPROVED BY ___ / DATE ___
REVISED BY K. MOORE	DATE 01/24/12		APPROVED BY ___ / DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 17-2 / REV 0

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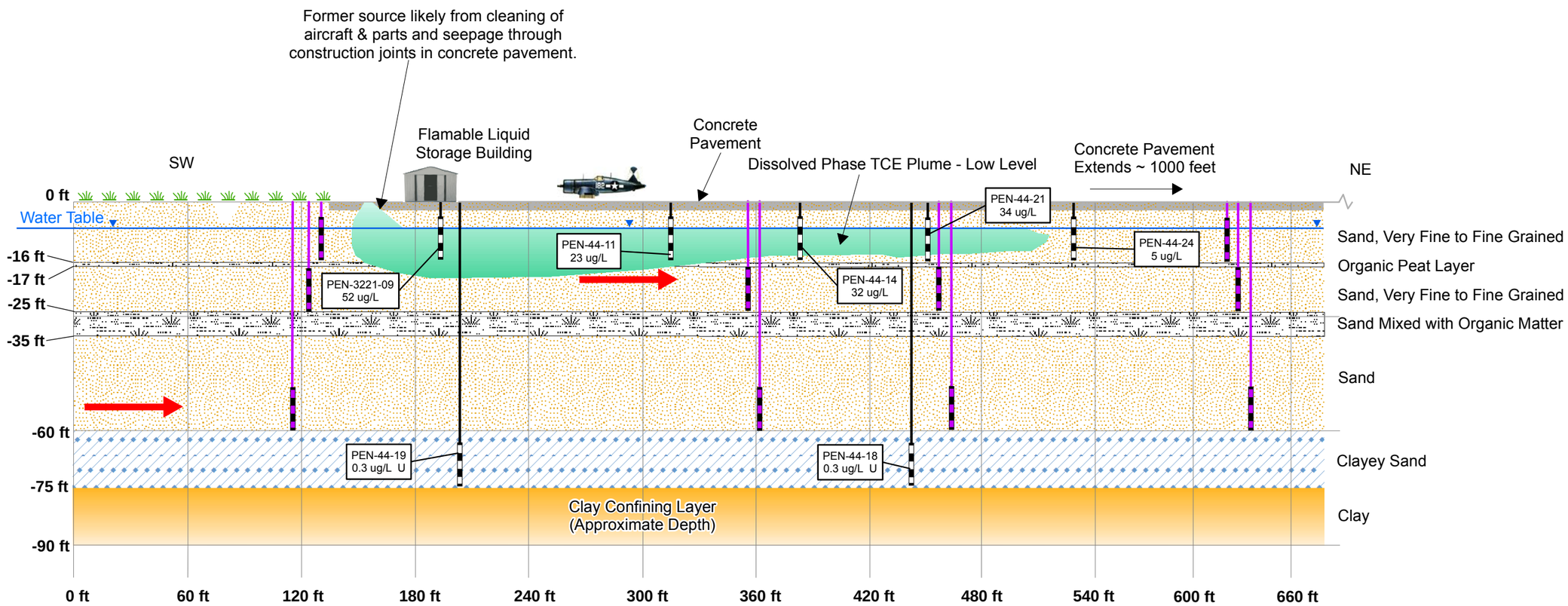


Legend

- Groundwater Flow Direction
- Monitoring Well
- Existing Monitoring Well Screen Interval
- New Monitoring Well
- New Monitoring Well Screen Interval

NOTES:
1. USEPA MCL for Trichloroethene is 5 ug/L; Florida MCL is 3 ug/L.
2. See Figure 17-2, for location of Cross Section A-A' and note related to new well locations.
3. ug/L = micrograms per liter

DRAWN BY K. MOORE	DATE 04/11/11	CROSS SECTION A-A' TRICHLOROETHENE CONCENTRATIONS IN 2005-2006 AND NEW WELLL LOCATIONS SITE 44 NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER — / CTO NUMBER 0079
CHECKED BY M. MAUGHON	DATE 01/31/12		APPROVED BY — / DATE —
REVISED BY J. ENGLISH	DATE 01/31/12		APPROVED BY — / DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 17-3 / REV 0

OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
EPA I.D. FL9170024567

Response to Florida Department of Environmental Protection Comments (October 28, 2011) on the Sampling *and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan), Groundwater Monitoring Work Plan for Operable Unit 19 (Site 44) Feasibility Study Addendum DRAFT dated July 2011 (Work Plan)*

(1) A figure should be provided showing the groundwater elevation contours and calculated groundwater flow direction.

Response: Appendix A of the UFP-SAP contains potentiometric surface maps for the investigations conducted prior to the Site 44 RI (2008), but potentiometric surface maps prepared for the Site 44 RI (2008) were inadvertently omitted in the UFP SAP. To provide additional data to support the CSM, the potentiometric maps (See Attachment 1) prepared for the Site 44 RI (2008) will be added to Appendix A in the UFP-SAP.

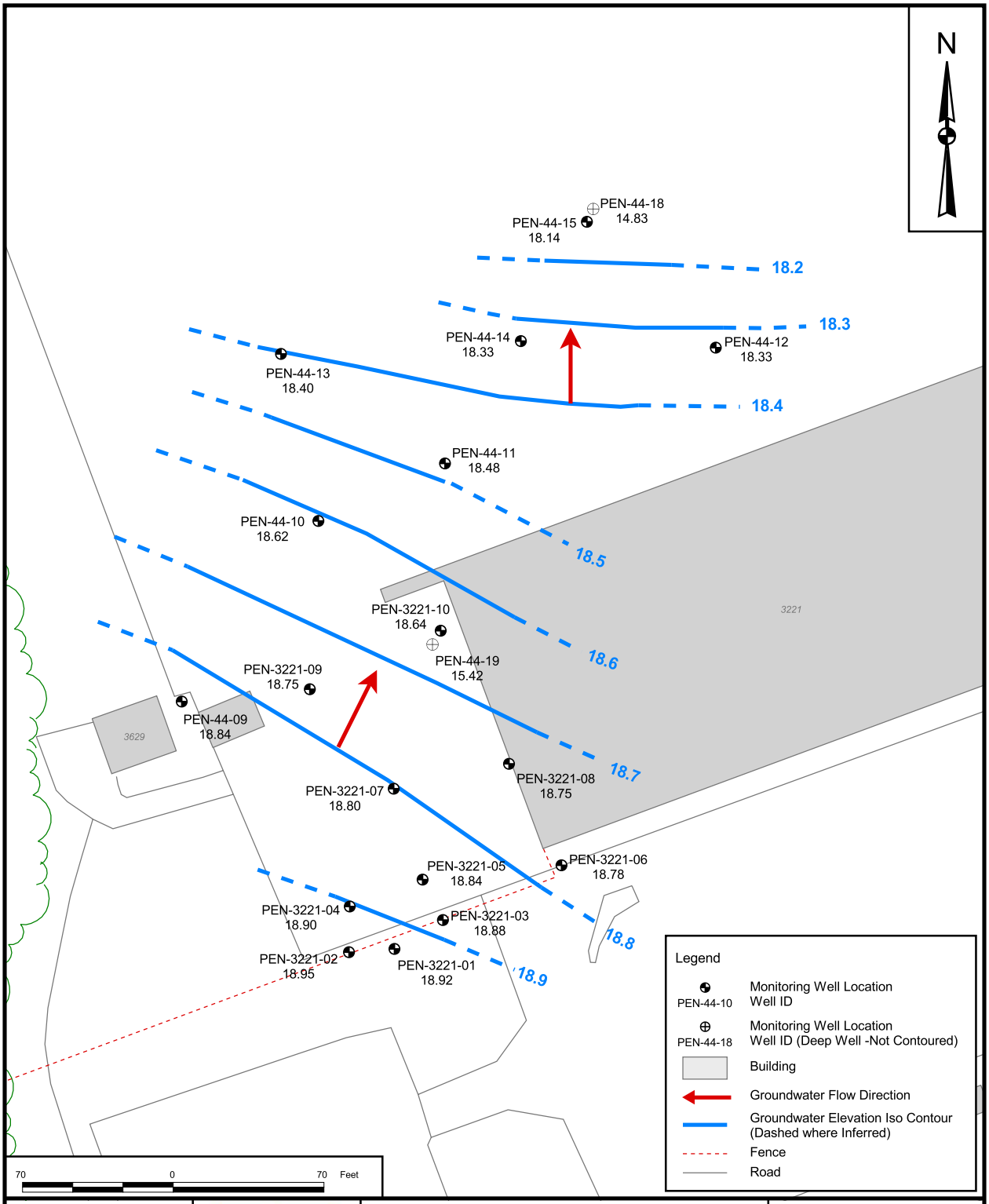
(2) Please provide a figure with the proposed boring locations/groundwater monitoring well installation locations in relation to the latest TCE contamination contours.

Response: Figures showing proposed soil sampling and monitoring well locations is provided in Attachment 2.

(3) Please provide a vertical cross-section of the site along the plume axis that shows the latest TCE contamination above groundwater cleanup target levels, monitoring well locations and screened depths, and the proposed boring locations/groundwater monitoring well installation locations and screened depths. The figure should provide a visual depiction of the TCE plume per the conceptual site model in relation to the proposed new monitoring well locations that clearly depicts how the new monitoring wells will help define the plume, provide points of groundwater compliance, and aid in refining the conceptual site model for Site 44.

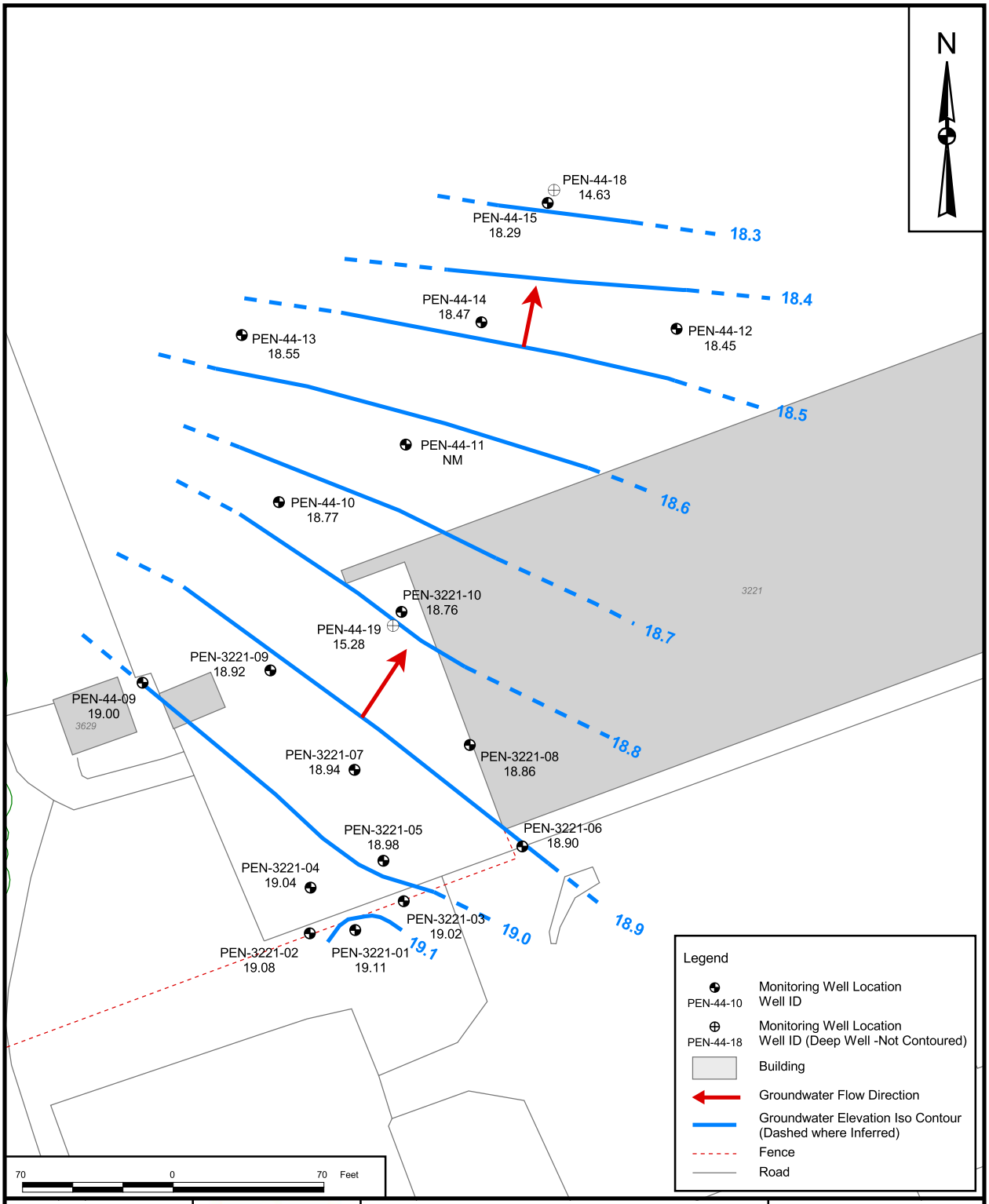
Response: The requested cross-section is provided in Attachment 3.

ATTACHMENT 1
Potentiometric Surface Maps from the 2008 Site 44 Remedial Investigation



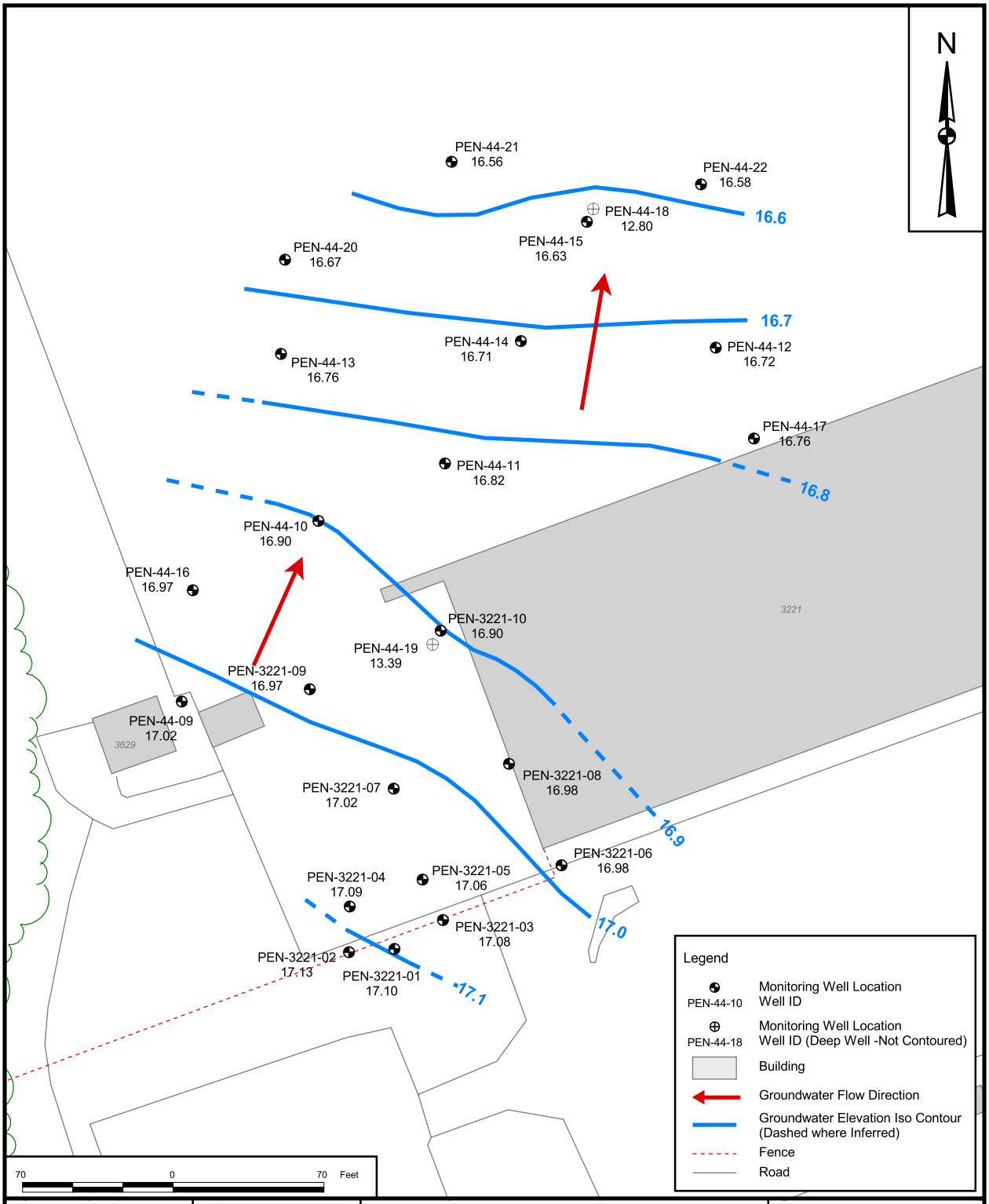
DRAWN BY	DATE		CONTRACT NUMBER
C. SPEHAR	1/20/06	GROUNDWATER ELEVATIONS	CTO 0367
CHECKED BY	DATE	SHALLOW MONITORING WELLS 12/06/05	APPROVED BY / DATE
B. OLSON	5/03/07	SITE 44 RI REPORT	— / —
COST/SCHEDULE-AREA		NAS PENSACOLA	APPROVED BY / DATE
		PENSACOLA, FLORIDA	— / —
SCALE			DRAWING NO. / REV
AS NOTED			FIGURE 3-2 / 0

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR MW LOCATION SITE 44 LAYOUT 5/03/07 JEE



DRAWN BY C. SPEHAR	DATE 1/20/06	GROUNDWATER ELEVATIONS SHALLOW MONITORING WELLS 12/20/05 SITE 44 RI REPORT NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0367
CHECKED BY B. OLSON	DATE 5/03/07		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-3 / REV 0

P:\GIS\PENSACOLA_NAS\MAPDOCS\APR\SITE44_45_46.APR SITE 44 POTENTIO 12202005 LAYOUT 5/03/07 JEE



DRAWN BY C. SPEHAR	DATE 1/20/06	GROUNDWATER ELEVATIONS SHALLOW MONITORING WELLS 05/12/06 SITE 44 RI REPORT NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0367
CHECKED BY B. OLSON	DATE 4/25/07		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-4 / REV 0

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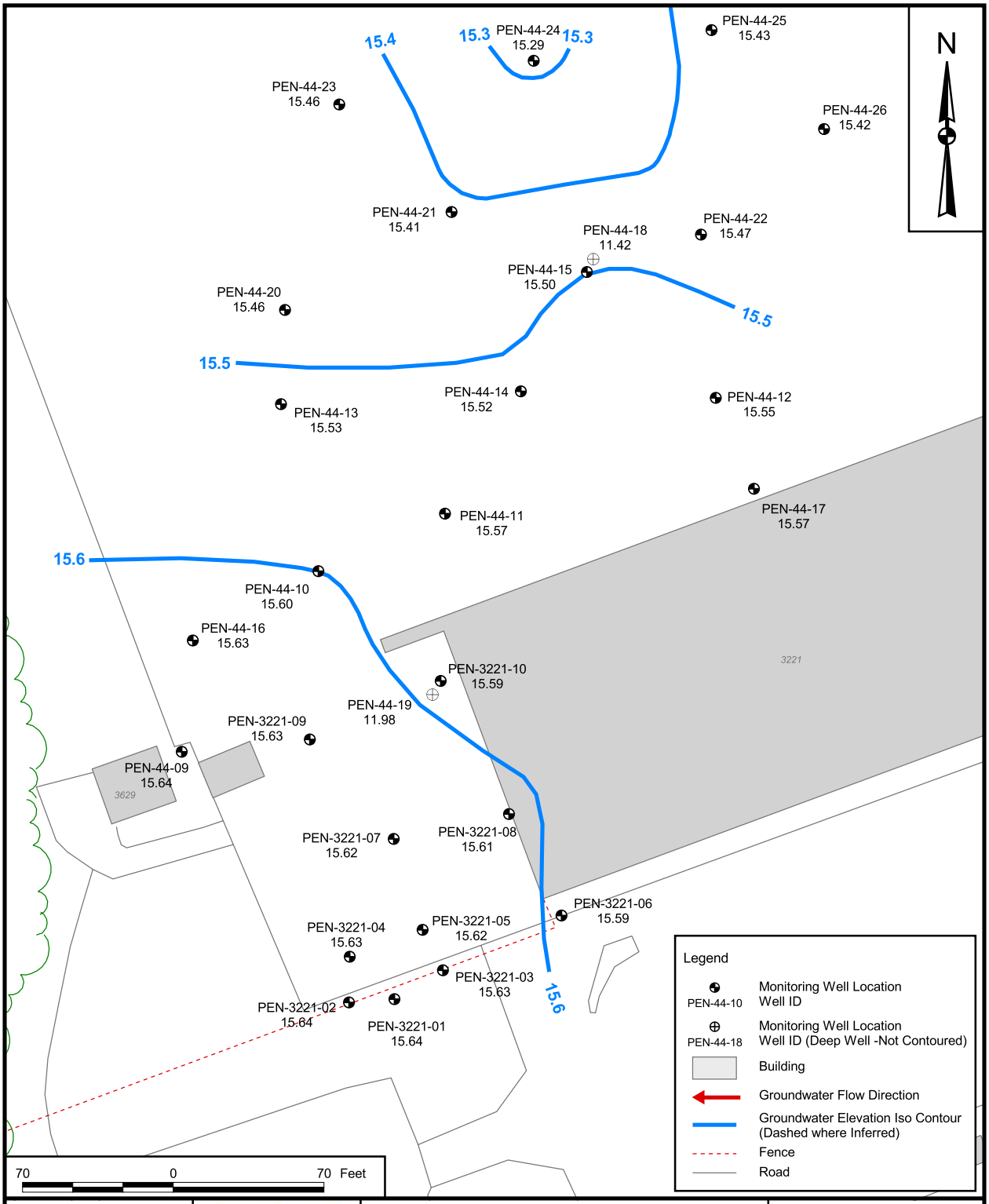

DRAWN BY C. SPEHAR — DATE 1/20/06	NAVFAC	GROUNDWATER ELEVATIONS SHALLOW MONITORING WELLS 08/14/06 SITE 44 RI REPORT NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0367
CHECKED BY B. OLSON — DATE 4/25/07			APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3-5 — REV 0

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ATTACHMENT 2
Proposed Soil Sampling and Monitoring Well Locations

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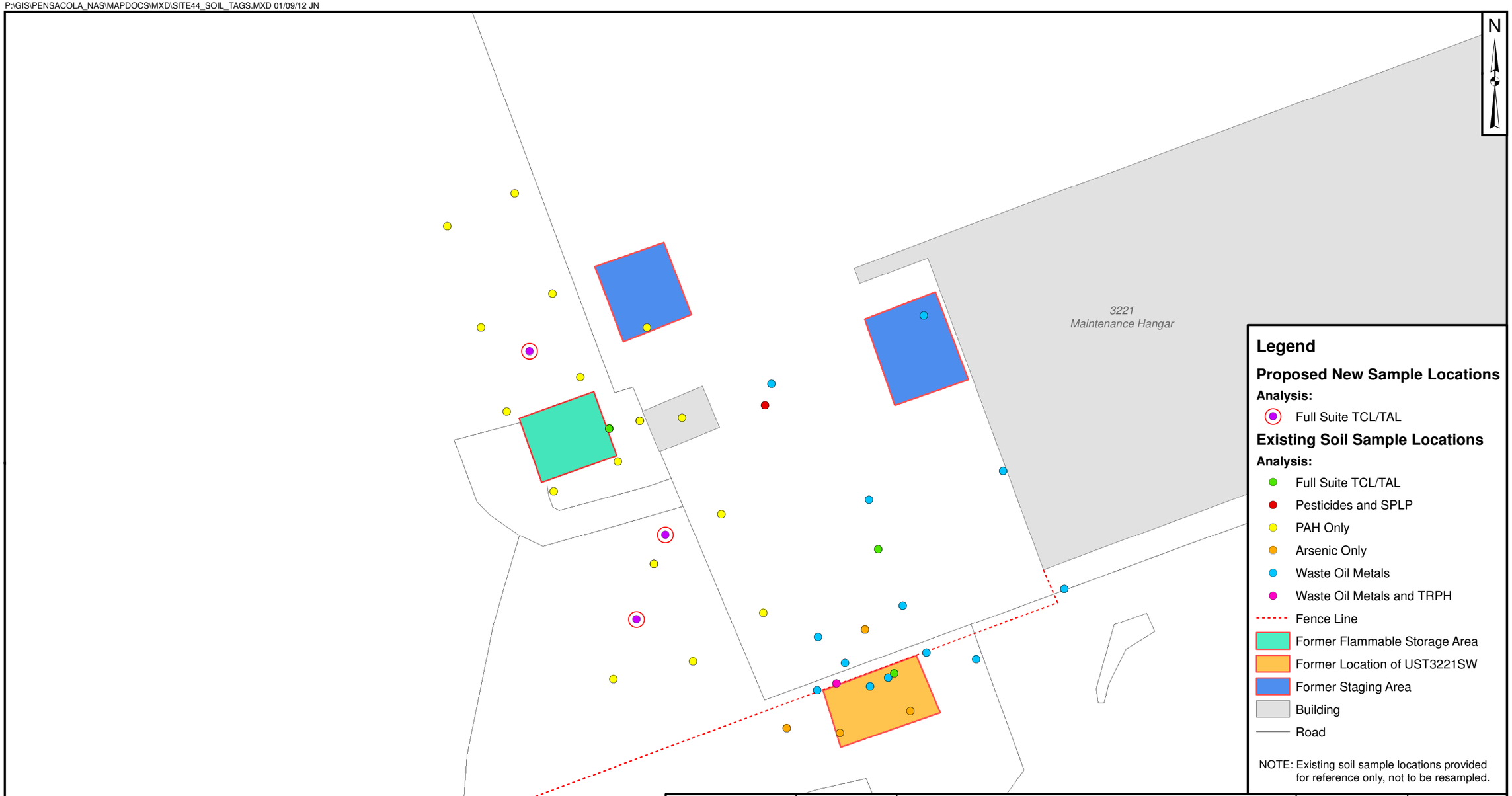

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K. MOORE	1/24/12
CHECKED BY	DATE
M. MAUGHON	1/24/12
REVISED BY	DATE
SCALE	
AS NOTED	

NAVFAC

SOIL SAMPLE LOCATIONS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
	0079
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO.	REV
FIGURE 17-1	0

ATTACHMENT 3
Cross Section

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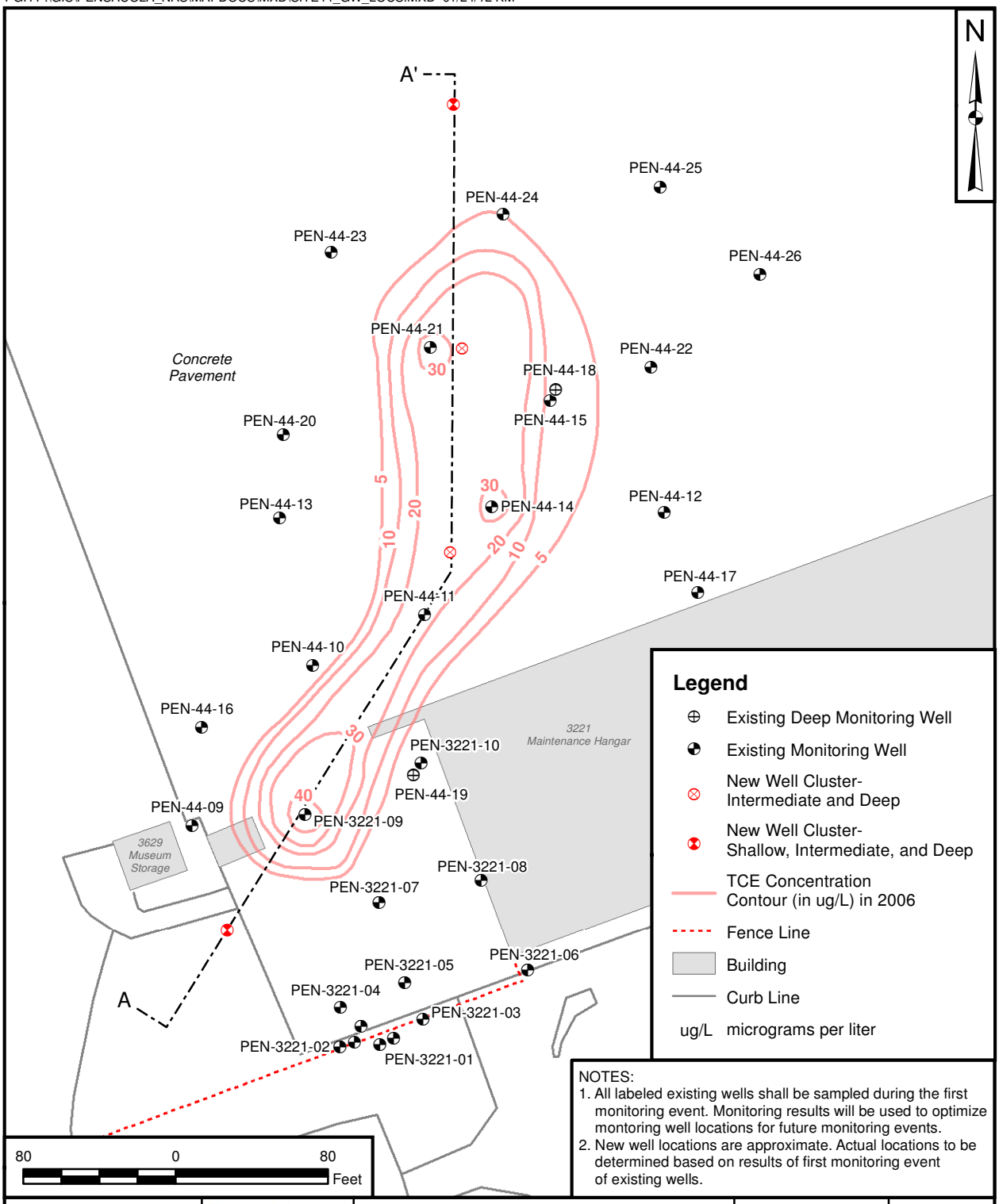
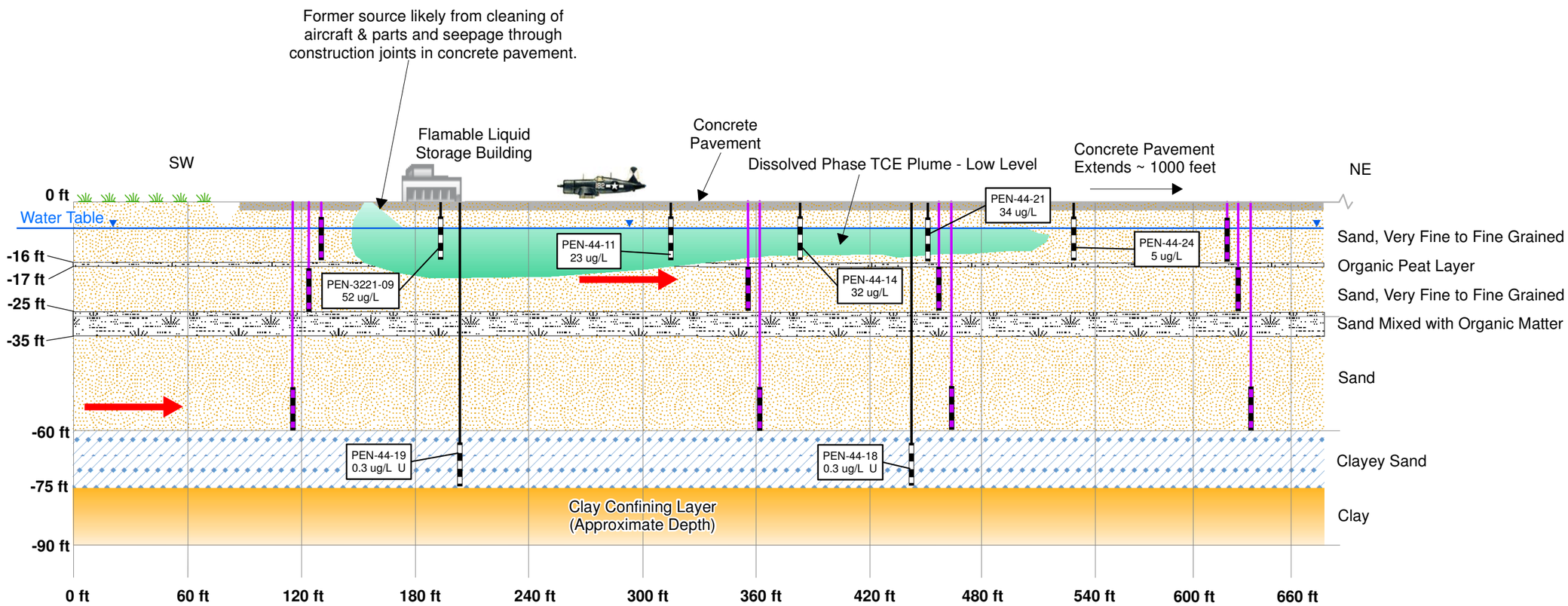


NOTES:
1. All labeled existing wells shall be sampled during the first monitoring event. Monitoring results will be used to optimize montoring well locations for future monitoring events.
2. New well locations are approximate. Actual locations to be determined based on results of first monitoring event of existing wells.

DRAWN BY J. ENGLISH	DATE 12/22/10	GROUNDWATER SAMPLE LOCATIONS SITE 44 NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER ___ / CTO NUMBER 0079
CHECKED BY M. MAUGHON	DATE 01/24/11		APPROVED BY ___ / DATE ___
REVISED BY K. MOORE	DATE 01/24/12		APPROVED BY ___ / DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 17-2 / REV 0

PGH P:\GIS\PENSACOLA_NAS\MXD\SITE44_CSM_AA.MXD 1/24/12 KM



Legend

- Groundwater Flow Direction
- Monitoring Well
- Existing Monitoring Well Screen Interval
- New Monitoring Well
- New Monitoring Well Screen Interval

NOTES:
1. USEPA MCL for Trichloroethene is 5 ug/L; Florida MCL is 3 ug/L.
2. See Figure 17-2, for location of Cross Section A-A' and note related to new well locations.
3. ug/L = micrograms per liter

DRAWN BY	DATE
K. MOORE	4/11/11
CHECKED BY	DATE
M. MAUGHON	1/24/12
REVISED BY	DATE
K. MOORE	1/24/12
SCALE	
AS NOTED	

NAVFAC

CROSS SECTION A-A'
TRICHLOROETHENE CONCENTRATIONS IN 2005-2006
AND NEW WELLL LOCATIONS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
___	0079
APPROVED BY	DATE
__	__
APPROVED BY	DATE
__	__
FIGURE NO. FIGURE 17-3	REV 0

RESPONSE TO EPA COMMENTS (APRIL 2012)
OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
EPA ID NO. FL9170024567

The following provides a response to U.S. Environmental Protection Agency (EPA) comments (April 16, 2012) on the Draft Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Groundwater Investigation for Operable Unit (OU) 19 - Site 44, Feasibility Study Addendum (March 2012).

EPA TECHNICAL REVIEW COMMENTS

Comment 1, Executive Summary, Page 5 of 159: The first paragraph on Page 5 of 159 of the Draft Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan), Groundwater Investigation for Operable Unit 19 - Site 44, Feasibility Study Addendum dated March 2012 (Draft SAP) indicates that the 1,000-gallon underground storage tank (UST) reportedly used to store PD-680 was removed in 1992. This date of removal is inconsistent with the date of removal described in other sections of the Draft SAP. Specifically, the text at the top of Page 37 of 159 indicates that the 1,000-gallon UST was removed in 1989-1990. Figure 10-6, Conceptual Site Model, also indicates that this UST was removed in 1989-1990. For consistency, revise the Executive Summary to indicate that the 1,000-gallon UST was removed in 1989-1990.

Response: The text on Page 5 of 159 has been revised as requested to indicate that the 1,000-gallon underground storage tank (UST) was removed in 1989-1990.

Comment 2, SAP Worksheet No. 10, Conceptual Site Model, Section 10.2.3, Remedial Investigation Report, Groundwater Assessment, Page 43 of 159: The first full paragraph on Page 43 of 159 references Figure 10-4 for a depiction of the six wells that reported concentrations of trichloroethylene (TCE) in groundwater in excess of the Florida Cleanup Target Level. However, Figure 10-4 is titled Cis-1,2-Dichloroethene Results. The title of Figure 10-4 is incorrect as the figure itself indicates TCE concentrations detected in groundwater. Figure 10-4 also identifies three different well locations as PEN-3221-09, all with the same TCE result of 52 micrograms per liter (µg/L). Two of the wells are located along the exterior western wall of Building 3221 outside of the 5 µg/L TCE concentration contour. Revise the title of Figure 10-4 so that it accurately reflects the information presented. Also, revise Figure 10-4 to accurately identify each well location with a distinct well identification and present the TCE result for each well.

Response: Figure 10-4 has been revised as requested and is attached.

Comment 3, SAP Worksheet No. 10, Conceptual Site Model, Section 10.3.2, Potential or Known Sources of Contamination, Page 47 of 159: The second paragraph on Page 47 of 159 states "...based on the results of site investigations during the CAR and RI at Site 44, including soil and groundwater sampling along the southwest side and northeast corner of Building 3221…the source of the Site 44 TCE groundwater plume appears to be due to wash rack activities and is not the result of activities inside Building 3221." Based on a review of Figure 10-3 through

Figure 10-5, the majority of sampling at Site 44 is along the southwest side and northwest corner of Building 3221, not the northeast corner. Revise SAP Worksheet No. 10, Conceptual Site Model to correctly identify the locations of previous sampling relative to Building 3221.

Response: The text on Page 47 of 159 has been revised as requested.

Comment 4, SAP Worksheet No. 10, Conceptual Site Model, Section 10.3.3, Migration Pathways and Potential Receptors, Page 50 of 159: The second paragraph on Page 50 of 159 states "Because waste material may be present in the subsurface, subsurface soil may be contaminated and groundwater that comes in contact with the waste may also become contaminated." The potential for waste material in the subsurface is not discussed elsewhere in the Draft SAP and the origin of this potential waste material is not described. Revise the Draft SAP to present additional information regarding potential buried waste, including the type and origin of the waste, potential contaminants of concern associated with this waste, depths encountered, etc. Additional investigations to better define the extent of this waste, if present, should be proposed.

Response: Based on historic site information, buried waste is not known to be present at the site. However, potential sources of chlorinated volatile organic compounds (cVOCs) are discussed in Section 10.3.2. The first paragraph of this section states: "Potential sources of the cVOC groundwater contamination that have been assessed at Site 44 include: the perimeter of the foundation of former Building 3629, which had been used for flammable liquid storage; the former staging area located to the northeast of Building 3629, the wash rack area; at the approximate location of UST 3221 SW; and the southwest side of Building 3221 which included a former materials staging area that was marked on the concrete (Figures 10-3, 10-4, and 10-5). With the exception of one soil boring at the wash rack area, cVOCs were not detected in soil samples collected above the water table. The cVOCs did not exceed screening criteria at the wash rack area sample location." This text after the first paragraph provides a summary of the assessment activities at potential source areas at Site 44 and ends with a paragraph that states: "Based on data from the CAR (1993) and RI (2008), the primary source of cVOC groundwater contamination at Site 44 is believed to be from routine aircraft or aircraft parts- maintenance and washing activities or undocumented minor spills in the wash rack area (Figures 10-3, 10-4, and 10-5). The current hypothesis is that dilute wash down water from historical wash rack operations may have seeped through concrete pavement construction joints and/or runoff the concrete wash rack area to adjacent grassed areas and seeped into groundwater (Figure 10-6)."

However, at the request of the EPA, as described in Section 11.1 Problem Statement, supplemental soil sampling will be conducted in the grassed area adjacent to Building 3629 to:

- **Confirm that the grassed area is not a source for the analytes detected in groundwater.**

- **Confirm direct soil exposure human health by comparison of the analytical results to Project Action Limits (PALSs).**
- **Assess the potential for a contaminant(s) to leach to groundwater.**

Data required to resolve this part of the problem statement is described in Section 11.2 Data Needs as described below.

- **Chemical soil data: Soil samples collected at the three locations in the grassed area adjacent to Building 3629 will be analyzed at a fixed-based laboratory for concentrations of USEPA CLP TCL and TAL metals and hexavalent chromium. The complete list of analytes is presented in Worksheet No. 15.**

The reference to buried waste was removed and the second paragraph on Page 50 of 159 was revised as follows:

"Because most of the site and the adjacent hydraulic downgradient area is paved with concrete for approximately 1,000 feet, there is no known completed human health risk pathway. Site use is expected to be industrial for the foreseeable future. Current and potential receptors at Site 44 include adult and adolescent trespassers, maintenance workers, construction workers, occupational workers, and hypothetical future residents."

Comment 5, SAP Worksheet No. 14, Summary of Project Tasks, Section 14.1.3, Soil Sampling, Page 61 of 159: The first paragraph on Page 61 of 159 states the soil "AQR Color-Tec® method will be conducted in accordance with the USEPA's SOPs for Analysis of Total Chlorinated Ethenes in Soil and Groundwater Using the Color Tec Screening Method and AQR Color-Tec® Method Procedures Manual." These standard operating procedures (SOPs) are not listed in SAP Worksheet No. 21, Project Sampling SOP References Table, nor do they appear to have been included in Appendix B, Field Standard Operating Procedures and Field Forms, based on a search for these titles within Appendix B. Revise the Draft SAP to identify all applicable SOPs in SAP Worksheet No. 21, including those for use of the AQR Color-Tec® method and append copies of these SOPs to the Draft SAP in Appendix B.

Response: The AQR Color-Tec® manual and EPA Standard Operating Procedures (SOPs) were inadvertently omitted in the draft SAP. Appendix B has been recompiled and is in the order of the Field Modification Form, Tetra Tech SOPs and the AQR Color-Tec® Manual and EPA SOPs. The EPA Color-Tec® SOP is the last SOP in the group of EPA SOPs. Worksheet 21 was revised to include the AQR Color-Tec® Manual and EPA SOPs as provided at: http://www.epa.gov/superfund/programs/dfa/fldmeth.htm.

Comment 6, SAP Worksheet No. 15, Reference Limits and Evaluation Table, Page 77 of 159: The notes for SAP Worksheet No. 15 on Page 77 of 159 indicate that project action limits (PALs) for soil considered the United States Environmental Protection Agency (EPA) Regions 3, 6, and 9 Regional Screening Levels (RSLs) for Protection of Groundwater Risk-Based soil screening levels (SSLs) based on a dilution attenuation factor (DAF) of 20, November 2011. The November 2011 RSL table only includes Protection of Groundwater Risk-Based SSLs based on a DAF of 1. The Draft SAP has not presented justification for adjusting the SSLs using

a DAF of 20 rather than the default DAF of 1. Revise the Draft SAP to present significant justification for use of Protection of Groundwater SSLs based on a DAF of 20, citing site-specific characteristics as appropriate. Alternatively, as a conservative measure, revise SAP Worksheet No. 15 to utilize Protection of Groundwater SSLs based on a DAF of 1.

Response: Worksheet 15 was revised for the EPA Groundwater SSLs and a DAF of 1 was used as a conservative screening criteria.

Comment 7, SAP Worksheet No. 17, Sampling Design and Rationale, Page 86 of 159: In SAP Worksheet No. 17, the first bulleted item under Round 2A states "Four borings will be conducted (1 upgradient, 2 along the spine of the plume, and 1 down gradient) and subsequently completed with a monitoring well." The fourth bulleted item states "The four intermediate monitoring wells will be screened based on the information described above." These statements suggest that only one intermediate monitoring well will be completed at each boring location. However, new well clusters (to include a shallow well, intermediate depth well, and deep well) will be completed, as described on Page 90 of 159 and as depicted in the cross section presented as Figure 17-3, Cross Section A-A' Trichloroethene Concentrations in 2005-2006 and New Well Locations. At two of the locations, shallow wells will not be installed because existing shallow wells will be used. To more accurately portray the proposed activities addressed in the Draft SAP, revise the information under Round 2A to clarify that well clusters will be installed at four locations to include a shallow well, intermediate well, and deep well. The first bulleted item under Round 2B should also be revised as it currently suggests that the only new wells are intermediate wells.

Response: The text was revised as requested.

Comment 8, SAP Worksheet No. 17, Sampling Design and Rationale, Groundwater Sampling, Page 89 of 159: The second paragraph on Page 89 of 159 identifies the three wells at which analysis of hexavalent chromium in groundwater was requested by EPA. One of the wells identified (PEN-322-09) could not be located on Figure 17-2, Groundwater Sample Locations. It appears that the well ID is incomplete and may be referring to well PEN-3221-09. For clarity, revise SAP Worksheet No. 17 to correctly identify the wells at which analysis of hexavalent chromium is proposed.

Response: The typographical error (now page 91 of the text with track changes shown) in Worksheet No. 17 was corrected.

Comment 9, SAP Worksheet No. 18, Sampling Locations and Methods/SOP Requirements Table, Page 93 of 159: Multiple discrepancies are identified between the information presented in SAP Worksheet No. 18 and other portions of the Draft SAP. The following discrepancies and/or other errors were identified:

- The first column header on the top of Page 94 of 159 is labeled Soil Sample ID. However, the information included under this column is for the groundwater water samples and identifies monitoring well IDs. Revise the table to correct this error.

Response: The column header was corrected.

- The table indicates that groundwater from well PEN-44-24 will be analyzed for tetrachloroethylene (PCE), TCE, cis-1,2-dichloroethylene (cis-DCE), vinyl chloride (VC), and natural attenuation (NA) parameters. Well PEN-44-24 was identified as a well for which the complete target compound list (TCL)/target analyte list (TAL) analyses was requested by EPA (Page 89 of 159). Revise SAP Worksheet No. 18 to propose TCL/TAL analysis for PEN-44-24.

Response: The table was revised as requested.

- The table indicates that analysis of hexavalent chromium will be conducted at well PEN-44-09, PEN-3221-02, and PEN-3221-03. These locations are inconsistent with those specified in SAP Worksheet No. 17, Sampling Design and Rationale, Page 89 of 159 [(PEN-3221-01, PEN-3221-05, and PEN-322-09 (presumably PEN-3221-09)]. Revise SAP Worksheet No. 18 to address these discrepancies.

Response: The discrepancies were revised as requested.

- The table indicates that the proposed Event 1 analyses for PEN-44-20 are "PCE, TCE, cis-DCE, VC L." It is unclear what is meant by the "L" as it is not defined in the table notes. The proposed analyses for PEN-44-26 are "PCE, TCE, cis-DCE, VC AL". Again, "AL" is not defined. For clarity, revise SAP Worksheet No. 18 to properly define all acronyms and abbreviations.

Response: The typographical errors in Worksheet No. 18 was corrected

Comment 10, Figure 10-8, Oxidation-Reduction Potential Results: Figure 10-8 does not depict the location of Building 3221 or Building 3629 in relation to the monitoring wells. To provide a frame of reference for the data points with respect to potential source areas, revise Figure 10-8 to also depict the footprint of Buildings 3221 and 3629.

Response: The figure was revised as requested and is attached.

ATTACHMENTS

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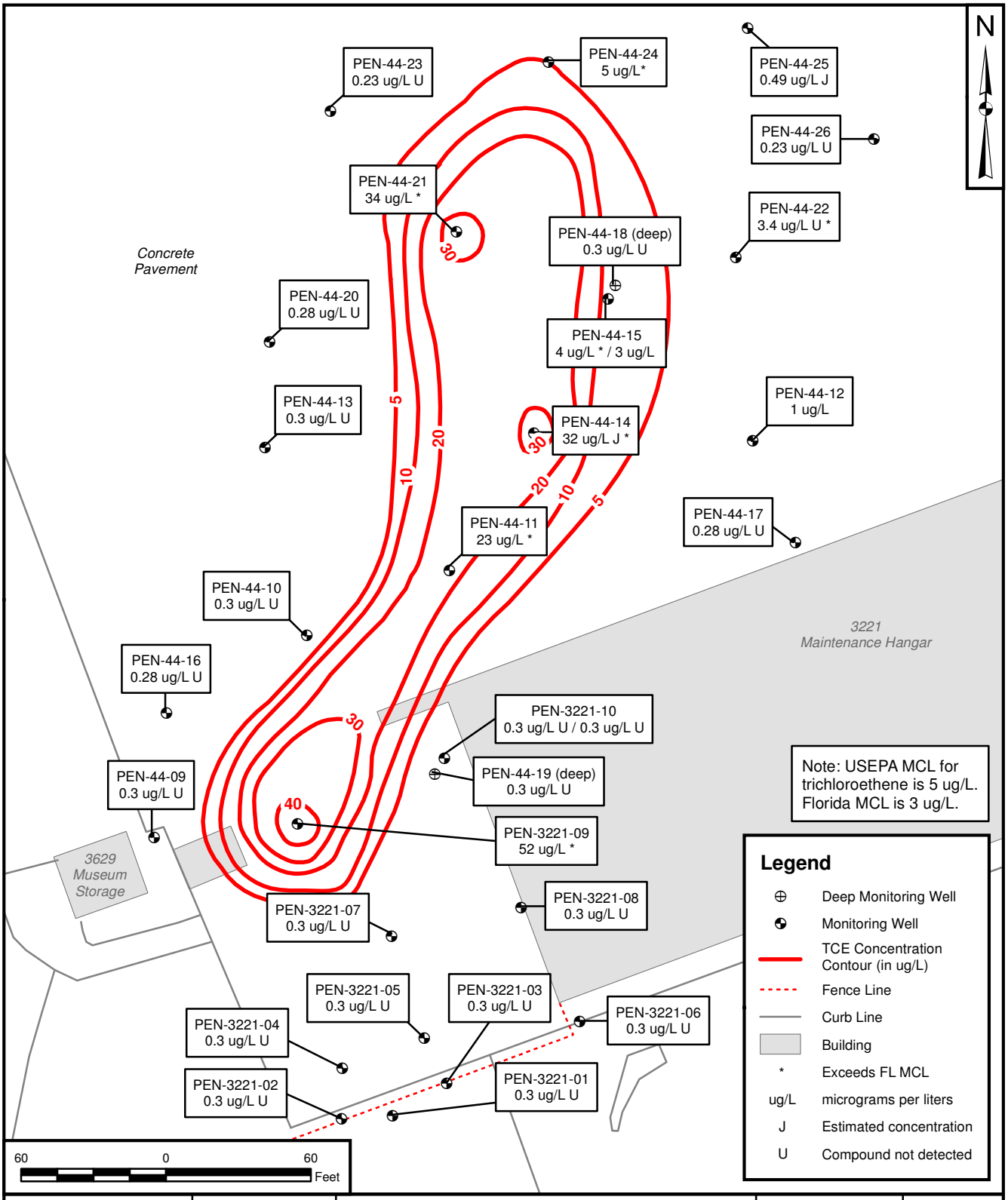

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J. ENGLISH	03/12/12
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F. LESESNE	05/02/12
REVISED BY	DATE
S. PAXTON	05/02/12
SCALE AS NOTED	

NAVFAC

TRICHLOROETHENE RESULTS
SITE 44
NAS PENSACOLA
PENSACOLA, FLORIDA

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FIGURE NO. FIGURE 10-4	REV 0

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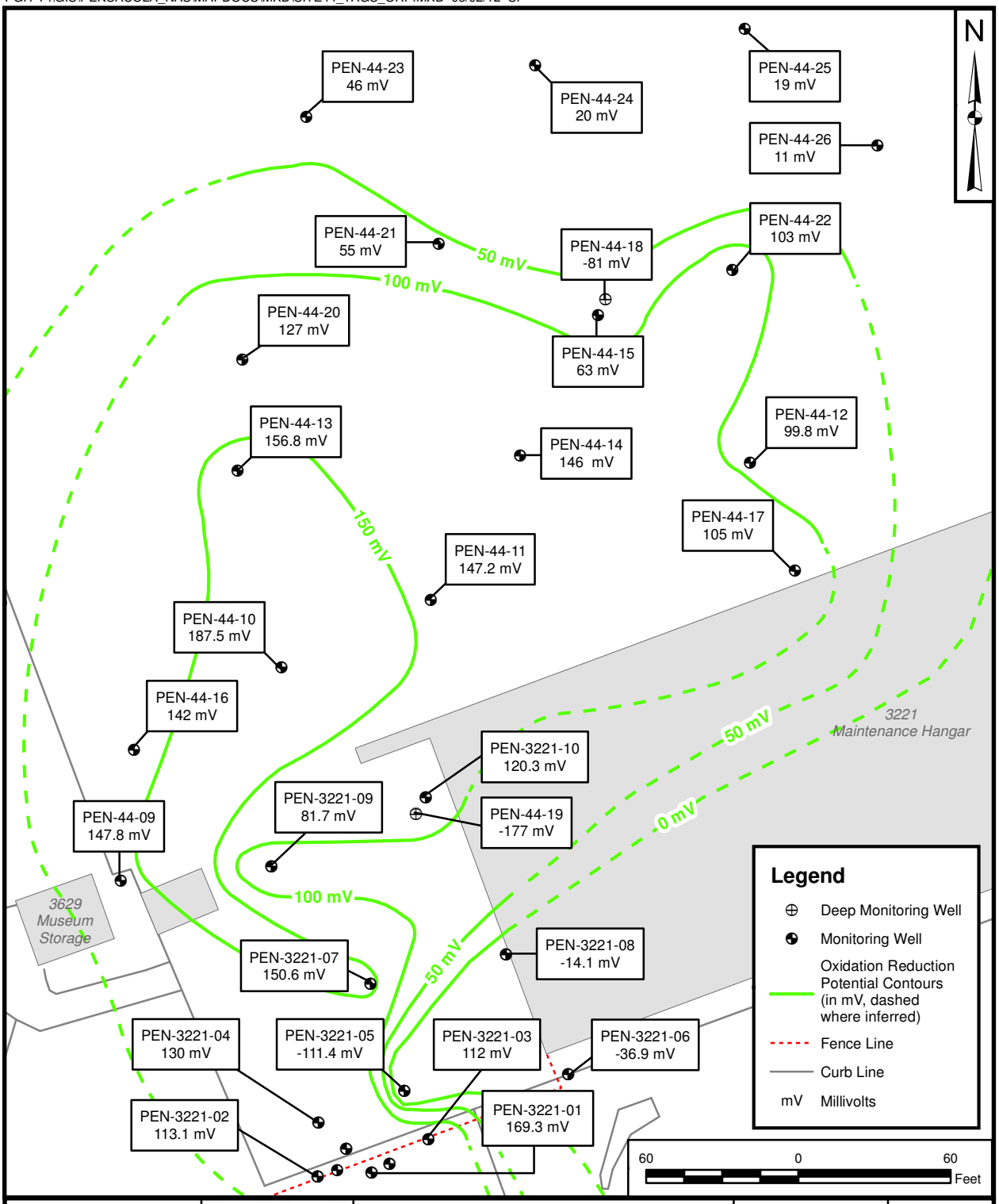

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CHECKED BY F. LESESNE	DATE 05/02/12		APPROVED BY ___	DATE ___
REVISED BY S. PAXTON	DATE 05/02/12		APPROVED BY ___	DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 10-8	REV 0

RESPONSE TO EPA COMMENTS (APRIL 2012)
OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
EPA ID NO. FL9170024567

Full UFP-QAPP Worksheet #	EPA Comment	Navy Response
A. Project Management		
Documentation		
Worksheet #1 Title and Approval Page	Missing Dated Signatures: EPA QAM or designated approving official	As with other UFP SAPs provided by the Navy to EPA, the EPA Remedial Project Manager is the approving official.
Worksheet #2 SAP Identifying Information	No comment	None required
Worksheet #3 Distribution List	Ensure all TBD personnel are included in the final SAP	The head librarian will be listed as the SAP Recipient for the John C. Pace Library at the University of West Florida. The well installation subcontractor that will be provide the drilling services described in the UFP SAP will not be selected until after the final UFP SAP has been approved by the EPA and FDEP, therefore, this SAP Recipient will remain listed as TBD.
Worksheet #4 Project Personnel Sign-Off Sheet	No comment	None required
Project Organization		
Worksheet #5 Project Organizational Chart	No comment	None required
Worksheet #6 Communication Pathways	EPA Should be notified of any significant corrective action taken	This information has been added.
Worksheet #7 Personnel Responsibilities and Qualifications Table	No comment	None required
Worksheet #8 Special Personnel Training Requirements Table	No comment	None required
Worksheet #9 Project Scoping Session Participants Sheet	No comment	None required

RESPONSE TO EPA COMMENTS (APRIL 2012)
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NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
EPA ID NO. FL9170024567

Full UFP-QAPP Worksheet #	EPA Comment	Navy Response
Worksheet #10 Conceptual Site Model	See Formal comments addressing secondary data	See response to Formal Comments.
Worksheet #11 Project Quality Objectives/Systematic Planning Process Statements	No comment	None required
Worksheet #12 Measurement Performance Criteria Table	No comment	None required
Worksheet #13 Secondary Data Criteria and Limitations Table	Rationale and relevance of secondary data to project not provided.	The rationale for using the data was discussed in Worksheet 9 Project Scoping Session Participants Sheet and Worksheet 11 Project Quality Objectives/Systematic Planning Process Statements.
Worksheet #14 Summary of Project Tasks	See Formal Comments	See Response to Formal Comments.
Worksheet #15 Reference Limits and Evaluation Table	See Formal Comments	See Response to Formal Comments
Worksheet #16 Project Schedule/Timeline Table	No comment	None required
B. Measurement Data Acquisition		
Sampling Tasks		
Worksheet #17 Sampling Design and Rationale	See Formal Comments	See Response to Formal Comments
Worksheet #18 Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements Table	See Formal Comments	See Response to Formal Comments

RESPONSE TO EPA COMMENTS (APRIL 2012)
OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
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EPA ID NO. FL9170024567

Full UFP-QAPP Worksheet #	EPA Comment	Navy Response
Worksheet #19 Analytical SOP Requirements Table	No comment	None required
Worksheet #20 Field Quality Control Sample Summary Table	No comment	None required
Worksheet #21 Project Sampling SOP References Table Sampling SOPs	Have not identified on-site support facilities that are available to field staff. Additionally does not identify key study personnel in charge of or overseeing sampling/collection activities.	Text will be added to Worksheet 14 in section 14.1.1 Mobilization/Demobilization to describe the availability of on-site facilities. The text to be added is as follows: Potable water and electricity are available at the Site, however, subcontractors will be required to have a portable source of electricity. Sanitary facilities are not available at the work site. Because of the short duration of the field activities, project field office and storage areas are not provided.“
Worksheet #22 Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Does not identify the availability and location of spare parts.	Text will be added to Worksheet 14 in section 14.1.1 Mobilization/Demobilization to describe the availability and location of spare parts. The text to be added is as follows: “Because of the short duration of the field activities, field equipment will be checked for completeness and operation by the field operation leader prior to mobilization. Spare parts will not be maintained in the field and will be shipped by the equipment supplier by express delivery if needed.”
Analytical Task		
Worksheet #23 Analytical SOP References Table	No comment	None required
Worksheet #24 Analytical Instrument Calibration Table	Does not identify the type of documentation required for calibrations and instrument checks and does not discuss how calibrations are traced back to specific instruments for each analytical parameter.	Appendix B contains the requested information and includes the offsite fixed base laboratory SOPs, the AQR Color-Tec® Operation Manual and EPA SOPs for the AQR Color-Tec.

RESPONSE TO EPA COMMENTS (APRIL 2012)
OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
EPA ID NO. FL9170024567

Full UFP-QAPP Worksheet #	EPA Comment	Navy Response
Worksheet #25 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Does not provide a comprehensive list of the consumables such as, solvents reagents, buffer solutions, and other consumables or supplies required for the project. Does not identify individuals responsible for checking/inspecting supplies and consumables.	Appendix B contains the requested information and includes the offsite fixed base laboratory SOPs, the AQR Color-Tec® Operation Manual and EPA SOPs for the AQR Color-Tec.
Sample Collection		
Worksheet #26 Sample Handling System	No comment	None required
Worksheet #27 Sample Custody Requirements Table	No comment	None required
Quality Control (QC) Samples		
Worksheet #28 Laboratory QC Samples Table	Does not provide laboratory statistically derived quality control limits.	The limits provided in Worksheet 28 are DOD QSM version 4.2 limits when available all other limits are the laboratories statistically derived limits. No revision.
Data Management Tasks		
Worksheet #29 Project Documents and Records Table	Does not provide the retention time and location of study records, reports and formal documents.	The following statement on retention time will be added to Worksheet 29: "All project documents and records will be maintained in the NAS Pensacola Administrative Record Repository for the duration the site is listed on the National Priorities List."
Worksheet #30 Analytical Services Table	No comment	None required

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Full UFP-QAPP Worksheet #	EPA Comment	Navy Response
C. Assessment Oversight		
Worksheet #31 Planned Project Assessments Table	Discusses one or more of the following types of assessments: peer reviews, technical audits, surveillance, management system reviews, readiness reviews, quality system audits, performance evaluations, data quality assessments. EPA added the comment: "Only list lab system audits."	Peer review of work plans and reports will be added to Worksheet 31 (See Attachment 1).
Worksheet #32 Assessment Findings and Corrective Action Responses Table	Does not state EPA will be notified of assessment findings.	The EPA will not be notified of assessment findings, the lab audit results are between the laboratory and the accrediting body.
Worksheet #33 Quality Assurance (QA) Management Reports Table	No comment	None required
Worksheet #34 Verification (Step I) Process Table	No comment	None required
Worksheet #35 Validation (Steps IIa and IIb) Process Table	Data validation checklists need to be provided. Does not clearly discuss the criteria by which data will be accepted or rejected and Does not provide a comprehensive list of the data flags or qualifiers that will be assigned to noncompliant data points (including the definitions of these flags.)	Data validation checklists will not be utilized and hence are not provided. Data will be qualified as per the National functional guidelines as referenced in Worksheet 36. No revision.

RESPONSE TO EPA COMMENTS (APRIL 2012)
OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
EPA ID NO. FL9170024567

Full UFP-QAPP Worksheet #	EPA Comment	Navy Response
Worksheet #36 Analytical Data Validation (Steps IIa and IIb) Summary Table	No comment	None required
Worksheet #37 Usability Assessment	Draft SAP indicates rejected data may be used. However, rejected data should not be used for decision making purposes. Missing reference to SOP or guidance document outlining the data usability process.	The paragraph in Worksheet 37 concerning missing or rejected data will be revised as follows: "Missing or rejected data will be reviewed by the NAS Pensacola team to determine whether it has compromised the ability to make a decision(s) to the desired level of confidence, if it can be compensated for by other data, or if rejected how it can be best used to support the project objectives and decisions."

RESPONSE TO EPA COMMENTS (APRIL 2012)
OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
EPA ID NO. FL9170024567

Attachment 1

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (title and organizational affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation)	**Person(s) Responsible for Identifying and Implementing CA** (title and organizational affiliation)	**Person(s) Responsible for Monitoring Effectiveness of CA** (title and organizational affiliation)
Peer Review of Work Plans and Reports	Draft, Draft Final and Final Documents	Internal	Tetra Tech	Technical Experts and Technical Editors	Report Author	Project Manager	Project Manager

RESPONSE TO EPA COMMENTS (May 2012)
OU 19 SITE 44 (FORMER UST SITE 3221 SW)
NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA
EPA ID NO. FL9170024567

The following provides a response to U.S. Environmental Protection Agency (EPA) comments (May, 29, 2012) on the response to formal and check list comments dated April 16, 2012 for the Draft Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Groundwater Investigation for Operable Unit (OU) 19 - Site 44, Feasibility Study Addendum (March 2012).

Comment 5, SAP Worksheet No. 14, Summary of Project Tasks, Section 14.1.3, Soil Sampling, Page 61 of 159: ***The response to this comment is adequate. The original comment requested that the Draft Sampling and Analysis Plan (SAP) be revised to identify all applicable Standard Operating Procedures (SOPs) in SAP Worksheet No. 21, including those for use of the AQR Color-Tec® method and append copies of these SOPs to the SAP in Appendix B. Worksheet No. 21 has been revised appropriately. However, the Response to Comments did not include submittal of Appendix B to determine whether the applicable SOPs have been added as stated. The final SAP should be reviewed*** **to ensure that all applicable SOPs have been included in Appendix B of the SAP.**

Response: The AQR Color-Tec® method is provided in Appendix B, Appendix B is attached.

Comment 6, SAP Worksheet No. 15, Reference Limits and Evaluation Table, Page 77 of 159: ***The response to this comment is partially adequate. The Navy has revised Worksheet 15 to use Protection of Groundwater Soil Screening Levels (SSLs) based on a dilution attenuation factor (DAF) of 1, from the November 2011 USEPA Regional Screening Level (RSL) table. The changes have been made, however, only to those Project Action Limits (PALs) which were previously the Protection of Groundwater SSL based on a DAF of 20. Worksheet 15 notes that the PAL references for soil are the minimum of the Residential Soil Contaminant Target Level (SCTL) and Leachability SCTL (FDEP, 2005), USEPA RSL for Soil, Residential (USEPA, November 2011), and the USEPA RSL for Protection of Groundwater Risk-Based SSL using a DAF of 1 (USEPA, November 2011). Protection of Groundwater SSLs based on a DAF of 1 now may be lower than some of the other screening criteria. For example, Worksheet No. 15 identifies the PAL for fluoranthene as 230 milligrams per kilogram (mg/kg) based on the USEPA RSL for residential soil. However, this is not the lowest of the four criteria. The Protection of Groundwater SSL based on a DAF of 1 for fluoranthene is 70 mg/kg. The Protection of Groundwater SSL should be selected as the PAL for this constituent. Revise Worksheet No. 15 to select PALs using the approach described in the notes of the table for all constituents (i.e., the PAL is the minimum value of all four screening criteria.) Also, please note that the USEPA RSL table was updated in May 2012***.

Response: Worksheet 15 is attached. The updated USEPA RSL table (May 2012) was use to revised Worksheet 15.

Worksheet #21 Project Sampling SOP References Table Sampling SOPs: ***EPA commented that key study personnel in charge of or overseeing sampling/collection activities had not been identified. This comment has not been addressed.***

Response: Please refer to Worksheet #s 5, 6 and 7

Worksheet #24 Analytical Instrument Calibration Table: ***EPA commented that this worksheet does not identify the type of documentation required for calibrations and instrument checks and does not discuss how calibrations are traced back to specific instruments for each analytical parameter. The response indicates that the SOPs provided in Appendix B provide the requested information. However, Appendix B has not been provided for review in the Response to Comments. The final SAP should be reviewed to ensure that all applicable SOPs have been included in Appendix B of the SAP, and that they include the requested information.***

Response: Attached are the laboratory SOPs that will be provided in Appendices B and C of the UFP SAP.

Worksheet #25 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table: ***EPA commented that this worksheet does not provide a comprehensive list of the consumables such as, solvents reagents, buffer solutions, and other consumables or supplies required for the project. Also, it does not identify individuals responsible for checking/inspecting supplies and consumables. The response indicates that the SOPs provided in Appendix B provide the requested information. However, Appendix B has not been provided for review in the Response to Comments. The final SAP should be reviewed to ensure that all applicable SOPs have been included in Appendix B of the SAP, and that they include the requested information.***

Response: Attached are the laboratory SOPs that will be provided in Appendices B and C of the UFP SAP.

Worksheet #28 Laboratory QC Samples Table: ***EPA commented that the worksheet does not provide laboratory statistically derived quality control limits. Although the Navy states that the limits provided in Worksheet 28 are DOD QSM version 4.2 limits when available while all other limits are the laboratories statistically derived limits, the lab statistically derived limits for all compounds should be included to verify the lab can meet the data quality objectives. The lab statistically derived limits will demonstrate whether the laboratory can meet the DoD QSM limits.***

Response: Attached are the DOD QSM version 4.2 limits and Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in Solid and Water Matrices.

Worksheet #37 Usability Assessment: ***EPA commented that the worksheet is missing a reference to an SOP or guidance document outlining the data usability process. This comment has not been addressed.***

Response: Below is the requested revision to Worksheet 37, new text is shown in red.

SAP Worksheet No. 37 -- Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

Data Usability Assessment
The usability of the data generated during the groundwater investigation directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum, and the results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the evaluator will consult with other technically competent individuals to render sound technical assessments of these DQI characteristics: • **Completeness** For each matrix scheduled to be sampled, the Tetra Tech FOL, acting on behalf of the Project Team, will prepare a table listing to compare planned samples/analyses to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified, the Tetra Tech PM and Project Risk Assessor will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other Project Team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions. • **Precision** The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in Worksheets No. 12 and 28. This will also include a comparison of field and laboratory precision with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met, or if data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report. • **Accuracy** The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing percent recoveries of LCS, LCSD, MS, MSD, and surrogate compounds to

accuracy goals identified in Worksheet No. 28. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, MSs, and LCSs. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will also be described in the project report.

- **Representativeness**

  A Tetra Tech Project Scientist, identified by the Tetra Tech PM and acting on behalf of the Project Team, will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial and temporal data variations (as applicable), and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Project Scientist indicates that a quantitative analysis is required.

- **Comparability**

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

- **Sensitivity**

  The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether project sensitivity goals listed in Worksheet No. 15 were achieved. The overall sensitivity and LOQs from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described in the project report. The Tetra Tech Project Chemist may enlist the help of the Project Risk Assessor to evaluate deviations from planned sensitivity goals.

- **Project Assumptions, Data Usability and Data Outliers**

  The data usability assessment is performed at the conclusion of data collection activities, using the outputs from data verification and data validation. It is the data interpretation phase, which involves a qualitative and quantitative evaluation of environmental data to determine if the project data are of the right type, quality, and quantity to support the decisions that need to be made. It involves a retrospective evaluation of the systematic planning process, and, like the systematic planning process, involves participation by key members of the project team. The data usability assessment evaluates whether underlying assumptions used during systematic planning are supported, sources of uncertainty have been accounted for and are acceptable, data are representative of the population of interest, and the results can be used as intended, with the acceptable level of confidence.

  The Tetra Tech PM and designated team members will use the 5 step process presented in Data Quality Assessment: A Reviewer's Guide, EPA QA/G-9, EPA/240/B-06/002, February

2006 (Appendix B) to evaluate whether project assumptions are valid. This will typically be a qualitative evaluation but may be supported by quantitative evaluations. The type of evaluation depends on the assumption being tested. Quantitative assumptions include those related to data distributions (e.g., normal or log-normal) and estimates of data variability. Potential data outliers will be removed if a review of the associated data indicates that the results have an assignable cause that renders them inconsistent with the remainder of the data. During this evaluation, the team will consider whether outliers could be indications of unanticipated site conditions.

Step 1 **Review the project's objectives and sampling design:** *Review the key outputs defined during systematic planning (i.e.,PQOs or DQOs and MPCs) to make sure they are still applicable. Review the sampling design for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.*

Step 2 **Review the data verification and data validation outputs:** *Review available QA reports, including the data verification and data validation reports. Perform basic calculations and summarize the data (using graphs, maps, tables, etc.). Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant PT sample results, and SOP deviations) and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.*

Step 3 **Verify the assumptions of the statistical method(s), if designated to be used:** *Verify whether underlying assumptions for selected statistical methods (if documented in the QAPP) are valid. Common assumptions include the distributional form of the data, independence of the data, dispersion characteristics, homogeneity, etc. Depending on the robustness of the statistical method, minor deviations from assumptions usually are not critical to statistical analysis and data interpretation. If serious deviations from assumptions are discovered, then another statistical method may need to be selected.*

Step 4 **Implement the statistical method:** *Implement the specified statistical procedures for analyzing the data and review underlying assumptions. For decision projects that involve hypothesis testing (e.g., "concentrations of lead in groundwater are below the action level") consider the consequences for selecting the incorrect alternative; for estimation projects (e.g., establishing a boundary for surface soil contamination), consider the tolerance for uncertainty in measurements.*

Step 5 **Document data usability and draw conclusions:** *Determine if the data can be used as intended, considering implications of deviations and corrective actions. Discuss data quality indicators. Assess the performance of the sampling design and Identify limitations on data use. Update the conceptual site model and document conclusions. Prepare the data usability summary report which can be in the form of text and/or a table.*

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

After the completion of data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these DQI characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples with non-detected results, number of samples with detected results, and the proportion of samples with detected and non-detected results. The Project Team members, identified by the Tetra Tech PM, will assess whether the data collectively support the attainment of project objectives.

Missing or rejected data will be reviewed by the NAS Pensacola team to determine whether it has compromised the ability to make a decision(s) to the desired level of confidence, if it can be compensated for by other data, or if rejected how it can be best used to support the project objectives and decisions.

For statistical comparisons and mathematical manipulations, non-detected values will be represented by a concentration equal to one-half of the sample-specific reporting limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations.

Identify the personnel responsible for performing the usability assessment:

The Tetra Tech PM, Project Chemist, FOL, and Project Scientist will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the NAS Pensacola Partnering Team. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face-to-face meeting or teleconference, depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

APPENDIX B

FIELD STANDARD OPERATING PROCEDURES AND FIELD FORMS

The Standard Operating Procedures and Field Forms were provided in the Response to Comments for the Draft Final UFP-SAP and are provided in the Final UFP SAP.

APPENDIX C

LABORATORY STANDARD OPERATING PROCEDURES AND ACCREDITATIONS

EMPIRICAL LABORATORIES, LLC

The Certificate of Accreditation is provided in the Final UFP-SAP. The Standard Operating Procedures were provided in the Draft Final UFP-SAP and will be provided electronically upon request.

MICROSEEPS, INCORPORATED

The Certificate of Accreditation is provided in the Final UFP-SAP. The Standard Operating Procedures were provided in the Draft Final UFP-SAP and will be provided electronically upon request.

COLUMBIA ANALYTICAL SERVICES

The Certificate of Accreditation is provided in the Final UFP-SAP. The Standard Operating Procedures were provided in the Draft Final UFP-SAP and will be provided electronically upon request.

Worksheet 15 Revised

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
TAL Metals							
ALUMINUM	**7429-90-5**	**2300**	**USEPA Protection of GW**	**2500**	**40**	**20**	10
ANTIMONY	7440-36-0	0.27	USEPA Protection of GW	1	2	1.6	1
ARSENIC	7440-38-2	0.0013	USEPA Protection of GW	0.009	2	1.2	0.6
BARIUM	7440-39-3	82	USEPA Protection of GW	40	8	4	1
BERYLLIUM	7440-41-7	3.2	USEPA Protection of GW	5	1	0.4	0.2
CADMIUM	**7440-43-9**	**0.38**	**USEPA Protection of GW**	**2**	**1**	**0.4**	**0.2**
CALCIUM	7440-70-2	NC	None	NC	1000	400	200
CHROMIUM[1]	7440-47-3	0.00059	USEPA Protection of GW	0.004	2	0.8	0.4
COBALT	7440-48-4	0.21	USEPA Protection of GW	0.8	2.5	2	1
COPPER	7440-50-8	150	Residential SCTL	50	2	1.6	0.8
IRON	7439-89-6	270	USEPA Protection of GW	1800	20	12	6
LEAD	7439-92-1	14	USEPA Protection of GW	130	1	0.6	0.3
MERCURY	**7439-97-6**	**0.033**	**USEPA Protection of GW**	**0.22**	**0.033**	**0.033**	**0.013**
MAGNESIUM	7439-95-4	NC	None	NC	1000	600	200
MANGANESE	7439-96-5	180	USEPA RSL	60	3	1.2	0.6
NICKEL	7440-02-0	20	USEPA Protection of GW	43	2	1.2	0.6
POTASSIUM	7440-09-7	NC	None	NC	1000	600	200
SELENIUM	7782-49-2	0.26	USEPA Protection of GW	1.7	2	1	0.6
SILVER	**7440-22-4**	**0.6**	**USEPA Protection of GW**	**4**	**2**	**0.4**	**0.2**
SODIUM	7440-23-5	NC	None	NC	1000	600	200
THALLIUM	7440-28-0	0.14	USEPA Protection of GW	0.026	1.6	0.8	0.6
VANADIUM[2]	7440-62-2	78	USEPA Protection of GW	13	2.5	2	1
ZINC	7440-66-6	290	USEPA Protection of GW	760	4	2	1

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Miscellaneous							
CHROMIUM (HEXAVALENT)	18540-29-9	0.00059	USEPA Protection of GW	0.1	0.4	0.2	0.065
TCL VOCs							
1,1- DICHLOROETHANE	75-34-3	0.00068	USEPA Protection of GW	0.004	0.005	0.0025	0.00125
1,1,1-TRICHLOROETHANE	71-55-6	0.07	USEPA Protection of GW	0.6	0.005	0.0025	0.00125
1,1,2- TRICHLOROETHANE	79-00-5	0.000077	USEPA Protection of GW	0.000513333	0.005	0.0025	0.00125
1,1,2,2- TETRACHLORETHANE	79-34-5	0.000026	USEPA Protection of GW	0.0005	0.005	0.0025	0.00125
1,1,2-TRICHLORO-1,2,2-TRIFLUORO-ETHANE	76-13-1	130	USEPA Protection of GW	860	0.01	0.005	0.0025
1,1-DICHLOROETHENE	75-35-4	0.0025	USEPA Protection of GW	0.02	0.005	0.0025	0.00125
1,2- DICHLOROBENZENE	95-50-1	0.27	USEPA Protection of GW	1.8	0.005	0.0025	0.00125
1,2- DICHLOROETHANE	107-06-2	0.000042	USEPA Protection of GW	0.00028	0.005	0.0025	0.00125
1,2,3-TRICHLOROBENZENE	87-61-6	0.015	USEPA Protection of GW	0.1	0.005	0.0025	0.00125
1,2,4-TRICHLOROBENZENE	**120-82-1**	**0.0029**	**USEPA Protection of GW**	**0.02**	**0.005**	**0.0025**	**0.00125**
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.00000014	USEPA Protection of GW	0.0000007	0.01	0.005	0.0025
1,2-DIBROMOETHANE	106-93-4	0.0000018	USEPA Protection of GW	0.000012	0.005	0.0025	0.00125
1,2-DICHLOROPROPANE	78-87-5	0.00013	USEPA Protection of GW	0.0009	0.005	0.0025	0.00125
1,3-DICHLOROBENZENE	541-73-1	7	Leachability SCTL	2.3	0.005	0.0025	0.00125
1,4- DICHLOROBENZENE	106-46-7	0.0004	USEPA Protection of GW	0.003	0.005	0.0025	0.00125
1,4-DIOXANE*	123-91-1	0.00014	USEPA Protection of GW	0.0009	0.00667	0.00333	0.00167
2-BUTANONE	78-93-3	1.0	USEPA Protection of GW	5.7	0.01	0.005	0.0025
2-HEXANONE	591-78-6	0.0079	USEPA Protection of GW	0.05	0.01	0.005	0.0025
4-METHYL-2-PENTANONE	108-10-1	0.23	USEPA Protection of GW	0.87	0.01	0.005	0.0025
ACETONE	67-64-1	2.4	USEPA Protection of GW	8.3	0.02	0.01	0.005

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
BENZENE	71-43-2	0.0002	USEPA Protection of GW	0.001	0.005	0.0025	0.00125
BROMOCHLOROMETHANE	74-97-5	0.021	USEPA Protection of GW	0.14	0.005	0.0025	0.00125
BROMODICHLOROMETHANE	75-27-4	0.000032	USEPA Protection of GW	0.0002	0.005	0.0025	0.00125
BROMOFORM	**75-25-2**	**0.0021**	**USEPA Protection of GW**	**0.01**	**0.005**	**0.0025**	**0.00125**
BROMOMETHANE	74-83-9	0.0018	USEPA Protection of GW	0.012	0.01	0.005	0.0025
CARBON DISULFIDE	75-15-0	0.21	USEPA Protection of GW	1.4	0.005	0.0025	0.00125
CARBON TETRACHLORIDE	56-23-5	0.00015	USEPA Protection of GW	0.001	0.005	0.0025	0.00125
CHLOROBENZENE	108-90-7	0.049	USEPA Protection of GW	0.033	0.005	0.0025	0.00125
CHLOROETHANE (ethyl chloride)	75-00-3	0.06	Leachability SCTL	0.02	0.01	0.005	0.0025
CHLOROFORM	67-66-3	0.000053	USEPA Protection of GW	0.00035	0.005	0.0025	0.00125
CHLOROMETHANE	**74-87-3**	**0.01**	**Leachability SCTL**	**0.0033**	**0.01**	**0.005**	**0.0025**
CIS-1,2- DICHLOROETHENE	156-59-2	0.0082	USEPA Protection of GW	0.055	0.005	0.0025	0.00125
CIS-1,3- DICHLOROPROPENE[3]	10061-01-5	0.00015	USEPA Protection of GW	0.0007	0.005	0.0025	0.00125
CYCLOHEXANE	110-82-7	13	USEPA Protection of GW	87	0.005	0.0025	0.00125
DIBROMOCHLOROMETHANE	124-48-1	0.000039	USEPA Protection of GW	0.00026	0.005	0.0025	0.00125
DICHLORODIFLUOROMETHANE	75-71-8	0.3	USEPA Protection of GW	2	0.01	0.005	0.0025
ETHYLBENZENE	**100-41-4**	**0.0015**	**USEPA Protection of GW**	**0.01**	**0.005**	**0.0025**	**0.00125**
ISOPROPYLBENZENE (Cumene)	98-82-8	0.2	Leachability SCTL	0.067	0.005	0.0025	0.00125
METHYL ACETATE	79-20-9	3.2	USEPA Protection of GW	5.3	0.01	0.005	0.0025
METHYL TERT-BUTYL ETHER	**1634-04-4**	**0.0028**	**USEPA Protection of GW**	**0.019**	**0.005**	**0.0025**	**0.00125**
METHYLCYCLOHEXANE	108-87-2	NC	None	NC	0.005	0.0025	0.00125
METHYLENE CHLORIDE	**75-09-2**	**0.0025**	**USEPA Protection of GW**	**0.0067**	**0.01**	**0.005**	**0.0025**
STYRENE	100-42-5	0.11	USEPA Protection of GW	1.2	0.005	0.0025	0.00125
TETRACHLOROETHENE	**127-18-4**	**0.0023**	**USEPA Protection of GW**	**0.00022**	**0.005**	**0.0025**	**0.00125**

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
TOLUENE	108-88-3	0.5	Leachability SCTL	0.17	0.005	0.0025	0.00125
TOTAL XYLENES	1330-20-7	0.19	USEPA Protection of GW	0.067	0.015	0.0075	0.00375
TRANS-1,2- DICHLOROETHENE	156-60-5	0.025	USEPA Protection of GW	0.17	0.005	0.0025	0.00125
TRANS-1,3- DICHLOROPROPENE[3]	10061-01-5	0.00015	USEPA Protection of GW	0.0007	0.005	0.0025	0.00125
TRICHLOROETHENE	79-01-6	0.00016	USEPA Protection of GW	0.001	0.005	0.0025	0.00125
TRICHLOROFLUOROMETHANE	75-69-4	0.69	USEPA Protection of GW	4.6	0.01	0.005	0.0025
VINYL CHLORIDE	75-01-4	0.0000053	USEPA Protection of GW	0.00003	0.005	0.0025	0.00125
TCL SVOCs							
1,1'-BIPHENYL	92-52-4	0.0087	USEPA Protection of GW	0.058	0.333	0.167	0.0833
1,2,4,5-TETRACHLOROBENZENE	95-94-3	0.0058	USEPA Protection of GW	0.04	0.333	0.167	0.0833
2,2-OXYBIS(1-CHLOROPROPANE)	108-60-1	0.00011	USEPA Protection of GW	0.0007	0.333	0.167	0.0833
2,3,4,6-TETRACHLOROPHENOL	58-90-2	1.1	USEPA Protection of GW	1.1	0.333	0.167	0.0833
2,4,5-TRICHLOROPHENOL	95-95-4	0.07	Leachability SCTL	0.02	0.333	0.167	0.0833
2,4,6-TRICHLOROPHENOL	88-06-2	0.013	USEPA Protection of GW	0.02	0.333	0.167	0.0833
2,4-DICHLOROPHENOL	120-83-2	0.003	Leachability SCTL	0.001	0.333	0.167	0.0833
2,4-DIMETHYLPHENOL	105-67-9	0.32	USEPA Protection of GW	0.57	1.33	0.667	0.333
2,4-DINITROPHENOL	51-28-5	0.034	USEPA Protection of GW	0.02	3.33	1.67	0.833
2,4-DINITROTOLUENE	121-14-2	0.00028	USEPA Protection of GW	0.0001	0.333	0.167	0.0833
2,6-DINITROTOLUENE	606-20-2	0.0004	Leachability SCTL	0.0001	0.333	0.167	0.0833
2-CHLORONAPHTHALENE	91-58-7	2.9	USEPA Protection of GW	19.3	0.333	0.167	0.0833
2-CHLOROPHENOL	95-57-8	0.057	USEPA Protection of GW	0.2	0.333	0.167	0.0833
2-METHYLNAPHTHALENE	**91-57-6**	**0.14**	**USEPA Protection of GW**	**0.9**	**0.333**	**0.167**	**0.0833**
2-METHYLPHENOL (o-Cresol)	**95-48-7**	**0.3**	**Leachability SCTL**	**0.1**	**0.333**	**0.167**	**0.0833**
2-NITROANILINE	88-74-4	0.062	USEPA Protection of GW	0.03	1.33	0.667	0.333

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
2-NITROPHENOL	88-75-5	NC	None	NC	0.333	0.167	0.0833
3,3'-DICHLOROBENZIDINE	91-94-1	0.00071	USEPA Protection of GW	0.001	0.333	0.167	0.0833
3-NITROANILINE	99-09-2	0.01	Leachability SCTL	0.003	1.33	0.667	0.333
4,6-DINITRO-2-METHYLPHENOL	534-52-1	0.002	USEPA Protection of GW	0.013	3.33	1.67	0.833
4-BROMOPHENYL-PHENYLETHER	101-55-3	NC	None	NC	0.333	0.167	0.0833
4-CHLORO-3-METHYLPHENOL	59-50-7	0.4	Leachability SCTL	0.13	0.333	0.167	0.0833
4-CHLOROANILINE	106-47-8	0.00013	USEPA Protection of GW	0.0009	0.333	0.167	0.0833
4-CHLOROPHENYL-PHENYL ETHER	7005-72-3	NC	None	NC	0.333	0.167	0.0833
4-METHYLPHENOL (p-Cresol)	106-44-5	0.03	Leachability SCTL	0.01	0.333	0.167	0.0833
4-NITROANILINE	100-01-6	0.0014	USEPA Protection of GW	0.003	1.33	0.667	0.333
4-NITROPHENOL	100-02-7	0.3	Leachability SCTL	0.1	1.33	0.667	0.333
ACENAPHTHENE	83-32-9	2.1	Leachability SCTL	0.7	0.333	0.167	0.0833
ACENAPHTHYLENE	208-96-8	27	Leachability SCTL	9	0.333	0.167	0.0833
ANTHRACENE	120-12-7	4.2	USEPA Protection of GW	280	0.333	0.167	0.0833
ATRAZINE	1912-24-9	0.00017	USEPA Protection of GW	0.001	0.333	0.167	0.0833
BENZALDEHYDE	**100-52-7**	**0.33**	**USEPA Protection of GW**	**1.6**	**0.333**	**0.167**	**0.0833**
BENZO (A) ANTHRACENE*	56-55-3	0.01	USEPA Protection of GW	0.05	0.00667	0.00333	0.00167
BENZO (A) PYRENE*	**50-32-8**	**0.0035**	**USEPA Protection of GW**	**0.005**	**0.00667**	**0.00333**	**0.00167**
BENZO (B) FLUOROANTHENE*	205-99-2	0.035	USEPA Protection of GW	0.05	0.00667	0.00333	0.00167
BENZO (G,H,I) PERYLENE	191-24-2	2500	RES SCTL	56.7	0.333	0.167	0.0833
BENZO (K) FLUOROANTHENE	207-08-9	0.35	USEPA Protection of GW	0.5	0.333	0.167	0.0833
BIS(2-CHLOROETHOXY) METHANE	111-91-1	63	Leachability SCTL	0.07	0.333	0.167	0.0833
BIS-(2-CHLOROETHYL) ETHER	111-44-4	0.0000031	USEPA Protection of GW	0.000002	0.333	0.167	0.0833
BIS(2-ETHYLHEXYL) PHTHALATE	117-81-7	0.017	USEPA Protection of GW	0.11	0.333	0.167	0.0833

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
BUTYLBENZYLPHTHALATE	**85-68-7**	**0.2**	**USEPA Protection of GW**	**1.3**	**0.333**	**0.167**	**0.0833**
CAPROLACTAM	105-60-2	1.9	USEPA Migration to GW	12.7	0.333	0.167	0.0833
CARBAZOLE	**86-74-8**	**0.2**	**Leachability SCTL**	**0.067**	**0.333**	**0.167**	**0.0833**
CHRYSENE	218-01-9	1.1	USEPA Protection of GW	5	0.333	0.167	0.0833
DIBENZO (A,H)-ANTHRACENE*	53-70-3	0.011	USEPA Protection of GW	0.005	0.00667	0.00333	0.00167
DIBENZOFURAN	**132-64-9**	**0.11**	**USEPA Protection of GW**	**0.73**	**0.333**	**0.167**	**0.0833**
DIETHYLPHTHALATE	84-66-2	4.7	USEPA Protection of GW	28.7	0.333	0.167	0.0833
DIMETHYLPHTHALATE	131-11-3	380	Leachability SCTL	126	0.333	0.167	0.0833
DI-N-BUTYLPHTHALATE	84-74-2	1.7	USEPA Protection of GW	11.3	0.333	0.167	0.0833
DI-N-OCTYLPHTHALATE	117-84-0	1700	Res SCTL	560	0.333	0.167	0.0833
FLUORANTHENE	206-44-0	70	USEPA Protection of GW	76.6	0.333	0.167	0.0833
FLUORENE	86-73-7	4	USEPA Protection of GW	26.7	0.333	0.167	0.0833
HEXACHLOROBENZENE	118-74-1	0.00053	USEPA Protection of GW	0.003	0.333	0.167	0.0833
HEXACHLOROBUTADIENE	87-68-3	0.0005	USEPA Protection of GW	0.003	0.333	0.167	0.0833
HEXACHLOROCYCLOPENTADIENE	77-47-4	0.07	USEPA Protection of GW	0.47	0.333	0.167	0.0833
HEXACHLOROETHANE	67-72-1	0.00048	USEPA Protection of GW	0.0032	0.333	0.167	0.0833
INDENO (1,2,3-CD)-PYRENE	**193-39-5**	**0.12**	**USEPA Protection of GW**	**0.05**	**0.333**	**0.167**	**0.0833**
ISOPHORONE	78-59-1	0.022	USEPA Protection of GW	0.067	0.333	0.167	0.0833
NAPHTHALENE*	91-20-3	0.00047	USEPA Protection of GW	0.003	0.00667	0.00333	0.00167
NITROBENZENE	98-95-3	0.000079	USEPA Protection of GW	0.0005	0.333	0.167	0.0833
N-NITROSO DIPHENYLAMINE	86-30-6	0.057	USEPA Protection of GW	0.13	0.333	0.167	0.0833
N-NITROSO-DI-N PROPYLAMINE	621-64-7	0.000007	USEPA Protection of GW	0.000017	0.333	0.167	0.0833
PENTACHLOROPHENOL	87-86-5	0.0017	USEPA Protection of GW	0.01	1.33	0.667	0.333
PHENANTHRENE	85-01-8	250	Leachability SCTL	56.7	0.333	0.167	0.0833

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
PHENOL	108-95-2	0.05	Leachability SCTL	0.017	0.333	0.167	0.0833
PYRENE	129-00-0	9.5	USEPA Protection of GW	56.7	0.333	0.167	0.0833
TCL Pesticides							
4,4'-DDD	72-54-8	0.066	USEPA Protection of GW	0.44	0.00067	0.00034	0.00017
4,4'-DDE	72-55-9	0.046	USEPA Protection of GW	0.31	0.00067	0.00034	0.00017
4,4'-DDT	50-29-3	0.067	USEPA Protection of GW	0.45	0.00067	0.00034	0.00017
ALDRIN	309-00-2	0.000034	USEPA Protection of GW	0.00023	0.00067	0.00034	0.00011
ALPHA-BHC	319-84-6	0.000036	USEPA Protection of GW	0.0001	0.00067	0.00034	0.00011
ALPHA-CHLORDANE[4]	5103-71-9	0.0018	USEPA Protection of GW	0.087	0.00067	0.00034	0.00011
BETA-BHC	**319-85-7**	**0.00013**	**USEPA Protection of GW**	**0.0003**	**0.00067**	**0.00034**	**0.00011**
DELTA-BHC	319-86-8	0.2	Leachability SCTL	0.067	0.00067	0.00034	0.00011
DIELDRIN	60-57-1	0.000061	USEPA Protection of GW	0.0004	0.00067	0.00034	0.00017
ENDOSULFAN I[5]	959-98-8	1.1	USEPA Protection of GW	1.3	0.00067	0.00034	0.00011
ENDOSULFAN II[5]	33213-65-9	1.1	USEPA Protection of GW	1.3	0.00067	0.00034	0.00017
ENDOSULFAN SULFATE[5]	1031-07-8	1.1	USEPA Protection of GW	1.3	0.00067	0.00034	0.00017
ENDRIN[6]	72-20-8	0.068	USEPA Protection of GW	0.33	0.00067	0.00034	0.00017
ENDRIN ALDEHYDE[6]	7421-93-4	0.068	USEPA Protection of GW	0.33	0.00067	0.00034	0.00017
ENDRIN KETONE[6]	53494-70-5	0.068	USEPA Protection of GW	0.33	0.00067	0.00034	0.00017
GAMMA-BHC (LINDANE)	**58-89-9**	**0.00021**	**USEPA Protection of GW**	**0.0014**	**0.00067**	**0.00034**	**0.00011**
GAMMA-CHLORDANE[4]	5103-74-2	0.0018	USEPA Protection of GW	0.087	0.00067	0.00034	0.00011
HEPTACHLOR	**76-44-8**	**0.00014**	**USEPA Migration to GW**	**0.0009**	**0.00067**	**0.00034**	**0.00011**
HEPTACHLOR EPOXIDE	1024-57-3	0.000068	USEPA Protection of GW	0.0004	0.00067	0.00034	0.00011
METHOXYCHLOR	72-43-5	1.5	USEPA Protection of GW	10	0.00067	0.00034	0.00011
TOXAPHENE	8001-35-2	0.0021	USEPA Protection of GW	0.014	0.033	0.022	0.011

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (mg/kg)	PAL Reference	Practical Quantitation Limit Goal (PQLG) (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
TCL PCBs							
AROCLOR-1016	12674-11-2	0.092	USEPA Protection of GW	0.13	0.0167	0.00833	0.00417
AROCLOR-1221	11104-28-2	0.000074	USEPA Protection of GW	0.0005	0.0167	0.00833	0.00417
AROCLOR-1232	11141-16-5	0.000074	USEPA Protection of GW	0.0005	0.0167	0.00833	0.00417
AROCLOR-1242	**53469-21-9**	**0.0053**	**USEPA Protection of GW**	**0.035**	**0.0167**	**0.00833**	**0.00417**
AROCLOR-1248	**12672-29-6**	**0.0052**	**USEPA Protection of GW**	**0.035**	**0.0167**	**0.00833**	**0.00417**
AROCLOR-1254	**11097-69-1**	**0.0088**	**USEPA Protection of GW**	**0.037**	**0.0167**	**0.00833**	**0.00417**
AROCLOR-1260	11096-82-5	0.024	USEPA Protection of GW	0.073	0.0167	0.00833	0.00417
TOTAL AROCLOR	1336-36-3	0.5	Res SCTL	0.17	0.0167	0.00833	0.00417

Notes:

The PAL references for soil are the minimum of: Soil Contaminant Target Level, F.A.C. 62-777 Residential Soil-Direct Exposure (Res SCTL) and Leachability to Groundwater Criteria (Leachability SCTL), Table II (FDEP, 2005); USEPA RSL: USEPA Regions 3, 6, and 9 Regional Screening Level for Soil, Residential (USEPA, May 2012); USEPA Protection of GW: USEPA Regions 3, 6, and 9 Regional Screening Level for Protection of Groundwater Risk-Based SSL using a dilution attenuation factor of 1 (USEPA, May 2012).

Bolded rows indicate that the PAL is between the laboratory LOQ and DL. The Partnering Team has agreed to accept this data for decision making if results below the LOQ are "J" qualified and the results are discussed in the monitoring report.

Shaded rows indicate the PAL is less than the DL; therefore, the Partnering Team has agreed to replace the PALs with the laboratory LOQs for decision making purposes, as suggested in "Guidance for the Selection of Analytical Methods for the Evaluation of Practical Quantitation Limits" (FDEP, 2004).

1) The value for hexavalent chromium is presented
2) The value presented is for Vanadium and compounds.
3) The value for 1,3-dichloropropene is presented.
4) The value for Chlordane is presented.
5) The value for Endosulfan is presented.
6) The value for Endrin is presented.

* indicates that these compounds will be reported from a low level scan analysis.

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
TAL Metals							
ALUMINUM	7429-90-5	200	SMCL	66.7	50	25	12.5
ANTIMONY	7440-36-0	0.6	Tapwater RSL	0.2	2.5	2	1.25
ARSENIC	7440-38-2	0.045	Tapwater RSL	0.015	2.5	1.5	0.75
BARIUM	7440-39-3	290	Tapwater RSL	96.7	10	2.5	1.25
BERYLLIUM	7440-41-7	1.6	Tapwater RSL	0.53	1.25	0.5	0.25
CADMIUM	**7440-43-9**	**0.69**	**Tapwater RSL**	**0.23**	**1.25**	**0.5**	**0.25**
CALCIUM	7440-70-2	NC	None	None	1250	500	250
CHROMIUM[1]	7440-47-3	0.031	Tapwater RSL	0.01	2.5	1	0.5
COBALT	7440-48-4	0.47	Tapwater RSL	0.16	3.125	2.5	1.25
COPPER	7440-50-8	62	Tapwater RSL	20.7	2.5	2	1
IRON	7439-89-6	300	GCTL	100	25	15	7.5
LEAD	7439-92-1	15	GCTL/Tapwater RSL	5	0.75	0.75	0.375
MERCURY	7439-97-6	0.063	Tapwater RSL	0.021	0.2	0.2	0.08
MAGNESIUM	7439-95-4	NC	None	None	1250	750	250
MANGANESE	7439-96-5	32	Tapwater RSL	10.7	3.75	1.5	0.75
NICKEL	7440-02-0	30	Tapwater RSL	10	2.5	1.5	0.75

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
POTASSIUM	7440-09-7	NC	None	None	1250	750	250
SELENIUM	7782-49-2	7.8	Tapwater RSL	2.6	2.5	1.25	0.75
SILVER	7440-22-4	7.1	Tapwater RSL	2.4	2.5	0.5	0.25
SODIUM	7440-23-5	160000	GCTL	53000	1250	750	250
THALLIUM	7440-28-0	0.016	Tapwater RSL	0.005	2	1	0.75
VANADIUM[2]	7440-62-2	7.8	Tapwater RSL	2.6	3.125	2.5	1.25
ZINC	7440-66-6	470	Tapwater RSL	157	5	2.5	1.25
Miscellaneous							
Hexavalent Chromium	18540-29-9	0.031	Tapwater RSL	0.01	0.02	0.01	0.009
TCL VOCs							
1,1-DICHLOROETHANE	75-34-3	2.4	Tapwater RSL	0.8	1	0.5	0.25
1,1,1-TRICHLOROETHANE	71-55-6	200	GCTL	66.7	1	0.5	0.25
1,1,2-TRICHLOROETHANE	79-00-5	0.024	Tapwater RSL	0.014	1	0.5	0.25
1,1,2,2-TETRACHLOROETHANE	79-34-5	0.066	Tapwater RSL	0.022	1	0.5	0.25
1,1,2-TRICHLORO-1,2,2-TRIFLUORO-ETHANE	76-13-1	5300	Tapwater RSL	1770	2	1	0.5
1,1-DICHLOROETHENE	75-35-4	7	GCTL	2.3	1	0.5	0.25
1,2-DICHLOROBENZENE	95-50-1	28	Tapwater RSL	9.3	1	0.5	0.25

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
1,2-DICHLOROETHANE	107-06-2	0.15	Tapwater RSL	0.05	1	0.5	0.25
1,2,3-TRICHLOROBENZENE	**87-61-6**	**0.52**	**Tapwater RSL**	**0.17**	**1**	**0.5**	**0.25**
1,2,4-TRICHLOROBENZENE	**120-82-1**	**0.99**	**Tapwater RSL**	**0.13**	**1**	**0.5**	**0.25**
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.00032	Tapwater RSL	0.0001	2	1	0.5
1,2-DIBROMOETHANE	106-93-4	0.0065	Tapwater RSL	0.0022	1	0.5	0.25
1,2-DICHLOROPROPANE	**78-87-5**	**0.38**	**Tapwater RSL**	**0.13**	**1**	**0.5**	**0.25**
1,3-DICHLOROBENZENE	541-73-1	210	GCTL	70	1	0.5	0.25
1,4-DICHLOROBENZENE	**106-46-7**	**0.42**	**Tapwater RSL**	**0.14**	**1**	**0.5**	**0.25**
1,4-DIOXANE	123-91-1	0.67	Tapwater RSL	0.22	40	20	10
2-BUTANONE	78-93-3	490	Tapwater RSL	163	10	5	2.5
2-HEXANONE	**591-78-6**	**3.4**	**Tapwater RSL**	**1.1**	**5**	**2.5**	**1.25**
4-METHYL-2-PENTANONE	108-10-1	100	Tapwater RSL	33.3	5	2.5	1.25
ACETONE	67-64-1	1200	Tapwater RSL	400	10	5	2.5
BENZENE	**71-43-2**	**0.39**	**Tapwater RSL**	**0.13**	**1**	**0.5**	**0.25**
BROMOCHLOROMETHANE	74-97-5	8.3	Tapwater RSL	2.8	1	0.5	0.25
BROMODICHLOROMETHANE	75-27-4	0.12	Tapwater RSL	0.04	1	0.5	0.25
BROMOFORM	75-25-2	4.4	GCTL	1.5	1	0.5	0.25

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BROMOMETHANE	**74-83-9**	**0.7**	**Tapwater RSL**	**0.23**	**2**	**1**	**0.5**
CARBON DISULFIDE	75-15-0	72	Tapwater RSL	24	1	0.5	0.25
CARBON TETRACHLORIDE	**56-23-5**	**0.39**	**Tapwater RSL**	**0.13**	**1**	**0.5**	**0.25**
CHLOROBENZENE	108-90-7	7.2	Tapwater RSL	2.4	1	0.5	0.25
CHLOROETHANE	75-00-3	12	GCTL	4	2	1	0.5
CHLOROFORM	67-66-3	0.19	Tapwater RSL	0.063	1	0.5	0.25
CHLOROMETHANE	74-87-3	2.7	GCTL	0.9	1	0.5	0.25
CIS-1,2-DICHLOROETHENE	156-59-2	2.8	Tapwater RSL	0.93	1	0.5	0.25
CIS-1,3-DICHLOROPROPENE[3]	**10061-01-5**	**0.41**	**Tapwater RSL**	**0.14**	**1**	**0.5**	**0.25**
CYCLOHEXANE	110-82-7	1300	Tapwater RSL	433	1	0.5	0.25
DIBROMOCHLOROMETHANE	124-48-1	0.15	Tapwater RSL	0.05	1	0.5	0.25
DICHLORODIFLUOROMETHANE	75-71-8	19	Tapwater RSL	6.3	2	1	0.5
ETHYLBENZENE	100-41-4	1.3	Tapwater RSL	0.43	1	0.5	0.25
ISOPROPYLBENZENE (Cumene)	**98-82-8**	**0.8**	**GCTL**	**0.27**	**1**	**0.5**	**0.25**
METHYL ACETATE	79-20-9	1600	Tapwater RSL	533	2	1	0.5
METHYL TERT-BUTYL ETHER	1634-04-4	12	Tapwater RSL	4	1	0.5	0.25
METHYL CYCLOHEXANE	108-87-2	NC	None	None	1	0.5	0.25

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METHYLENE CHLORIDE	75-09-2	5	MCL	1.6	2	1	0.5
STYRENE	100-42-5	100	MCL	33.3	1	0.5	0.25
TETRACHLOROETHENE	127-18-4	3	MCL	0.024	1	0.5	0.25
TOLUENE	108-88-3	40	GCTL	13.3	1	0.5	0.25
O-XYLENE	95-94-6	19	Tapwater RSL	6.3	1	0.5	0.25
m,p-XYLENE	179601-23-1	19	Tapwater RSL	6.3	2	1	0.5
TOTAL XYLENES	1330-20-7	19	Tapwater RSL	6.3	3	1.5	0.75
TRANS-1,2-DICHLOROETHENE	156-60-5	8.6	Tapwater RSL	2.9	1	0.5	0.25
TRANS-1,3-DICHLOROPROPENE[3]	**10061-02-6**	**0.41**	**Tapwater RSL**	**0.14**	**1**	**0.5**	**0.25**
TRICHLOROETHENE	**79-01-6**	**0.44**	**Tapwater RSL**	**0.087**	**1**	**0.5**	**0.25**
TRICHLOROFLUOROMETHANE	75-69-4	110	Tapwater RSL	36.7	2	1	0.5
VINYL CHLORIDE	75-01-4	0.015	Tapwater RSL	0.005	1	0.5	0.25
TCL SVOCs							
1,1'-BIPHENYL	92-52-4	0.083	Tapwater RSL	0.028	5	2.5	1.25
1,2,4,5-TETRACHLOROBENZENE	95-94-3	0.12	Tapwater RSL	0.04	5	2.5	1.25
2,2-OXYBIS(1-CHLOROPROPANE)	108-60-1	0.31	Tapwater RSL	0.1	5	2.5	1.25
2,3,4,6-TETRACHLOROPHENOL	58-90-2	17	Tapwater RSL	5.7	5	2.5	1.25

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2,4,5-TRICHLOROPHENOL	95-95-4	1	GCTL	0.33	5	2.5	1.25
2,4,6-TRICHLOROPHENOL	88-06-2	3.2	GCTL	0.3	5	2.5	1.25
2,4-DICHLOROPHENOL	120-83-2	3.5	GCTL	0.1	5	2.5	1.25
2,4-DIMETHYLPHENOL	105-67-9	27	Tapwater RSL	9	20	10	5
2,4-DINITROPHENOL	51-28-5	3	Tapwater RSL	1	50	25	8.33
2,4-DINITROTOLUENE	121-14-2	0.05	GCTL	0.017	5	2.5	1.25
2,6-DINITROTOLUENE	606-20-2	0.05	GCTL	0.017	5	2.5	1.25
2-CHLORONAPHTHALENE	91-58-7	55	Tapwater RSL	18.3	5	2.5	1.25
2-CHLOROPHENOL	95-57-8	7.1	Tapwater RSL	2.4	5	2.5	1.25
2-METHYLNAPHTHALENE*	91-57-6	2.7	Tapwater RSL	0.9	0.2	0.1	0.05
2-METHYLPHENOL	95-48-7	35	GCTL	11.7	5	2.5	1.25
2-NITROANILINE	**88-74-4**	**15**	**Tapwater RSL**	**5**	**20**	**10**	**5**
2-NITROPHENOL	88-75-5	NC	None	None	5	2.5	1.25
3,3'-DICHLOROBENZIDINE	91-94-1	0.08	GCTL	0.027	5	2.5	1.25
3-NITROANILINE[4]	99-09-2	1.7	GCTL	0.57	20	10	5
4,6-DINITRO-2-METHYLPHENOL	534-52-1	0.12	Tapwater RSL	0.04	20	10	5
4-BROMOPHENYL-PHENYLETHER	101-55-3	NC	None	None	5	2.5	1.25

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4-CHLORO-3-METHYLPHENOL	59-50-7	63	GCTL	21	5	2.5	1.25
4-CHLOROANILINE	106-47-8	0.32	Tapwater RSL	0.1	5	2.5	1.25
4-CHLOROPHENYL-PHENYL ETHER	7005-72-3	NC	None	None	5	2.5	1.25
4-METHYLPHENOL	**106-44-5**	**3.5**	**GCTL**	**1.2**	**5**	**2.5**	**1.25**
4-NITROANILINE	100-01-6	1.7	GCTL	0.57	20	10	5
4-NITROPHENOL	100-02-7	56	GCTL	18.7	20	10	5
ACENAPHTHENE*	83-32-9	20	GCTL	6.7	0.2	0.1	0.05
ACENAPHTHYLENE*	208-96-8	40	Tapwater RSL	13.3	0.2	0.1	0.05
ANTHRACENE*	120-12-7	130	Tapwater RSL	43.3	0.2	0.1	0.05
ATRAZINE	1912-24-9	0.26	Tapwater RSL	0.087	5	2.5	1.25
BENZALDEHYDE	100-52-7	150	Tapwater RSL	50	5	2.5	1.25
BENZO(A)ANTHRACENE*	56-55-3	0.029	Tapwater RSL	0.0097	0.2	0.1	0.05
BENZO(A)PYRENE*	50-32-8	0.0029	Tapwater RSL	0.00097	0.2	0.1	5
BENZO(B)FLUORANTHENE*	205-99-2	0.029	Tapwater RSL	0.0097	0.2	0.1	0.05
BENZO(G,H,I)PERYLENE*[5]	191-24-2	8.7	Tapwater RSL	2.9	0.2	0.1	0.05
BENZO(K)FLUORANTHENE*	207-08-9	0.29	Tapwater RSL	0.097	0.2	0.1	0.05
BIS(2-CHLOROETHOXY)METHANE	**111-91-1**	**4.7**	**Tapwater RSL**	**1.6**	**5**	**2.5**	**1.25**

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
BIS(2-CHLOROETHYL)ETHER	111-44-4	0.012	Tapwater RSL	0.004	5	2.5	1.25
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	0.071	Tapwater RSL	0.024	5	2.5	1.25
BUTYLBENZYLPHTHALATE	85-68-7	14	Tapwater RSL	4.7	5	2.5	1.25
CAPROLACTAM	105-60-2	770	Tapwater RSL	257	5	2.5	1.25
CARBAZOLE	**86-74-8**	**1.8**	**GCTL**	**0.6**	**5**	**2.5**	**1.25**
CHRYSENE*	218-01-9	2.9	Tapwater RSL	1	0.2	0.1	0.05
DIBENZO(A,H)ANTHRACENE*	53-70-3	0.0029	Tapwater RSL	0.00097	0.2	0.1	0.05
DIBENZOFURAN	132-64-9	0.58	Tapwater RSL	0.19	5	2.5	1.25
DIETHYL PHTHALATE	84-66-2	1100	Tapwater RSL	367	5	2.5	1.25
DIMETHYL PHTHALATE	131-11-3	70000	GCTL	23000	5	2.5	1.25
DI-N-BUTYL PHTHALATE	84-74-2	67	Tapwater RSL	22.3	5	2.5	1.25
DI-N-OCTYL PHTHALATE	117-84-0	140	GCTL	46.7	5	2.5	1.25
FLUORANTHENE*	206-44-0	63	Tapwater RSL	21	0.2	0.1	0.05
FLUORENE*	86-73-7	22	Tapwater RSL	7.3	0.2	0.1	0.05
HEXACHLOROBENZENE	118-74-1	0.042	Tapwater RSL	0.014	5	2.5	1.25
HEXACHLOROBUTADIENE	87-68-3	0.26	Tapwater RSL	0.087	5	2.5	1.25
HEXACHLOROCYCLOPENTADIENE	**77-47-4**	**2.2**	**Tapwater RSL**	**0.73**	**5**	**2.5**	**1.25**

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
HEXACHLOROETHANE	67-72-1	0.79	Tapwater RSL	0.17	5	2.5	1.25
INDENO(1,2,3-CD)PYRENE*	193-39-5	0.029	Tapwater RSL	0.0097	0.2	0.1	0.05
ISOPHORONE	78-59-1	37	GCTL	12.3	5	2.5	1.25
NAPHTHALENE*	**91-20-3**	**0.14**	**Tapwater RSL**	**0.047**	**0.2**	**0.1**	**0.05**
NITROBENZENE	98-95-3	0.12	Tapwater RSL	0.04	5	2.5	1.25
N-NITROSODIPHENYLAMINE	86-30-6	7.1	GCTL	2.4	5	2.5	1.25
N-NITROSO-DI-N-PROPYLAMINE	621-64-7	0.005	GCTL	0.0017	5	2.5	1.25
PENTACHLOROPHENOL	87-86-5	0.17	Tapwater RSL	0.057	20	10	5
PHENANTHRENE*[5]	85-01-8	8.7	Tapwater RSL	2.9	0.2	0.1	0.05
PHENOL	108-95-2	10	GCTL	3.3	5	2.5	1.25
PYRENE*	129-00-0	8.7	Tapwater RSL	2.9	0.2	0.1	0.05
TCL Pesticides							
4,4'-DDD	72-54-8	0.1	GCTL	0.033	0.02	0.01	0.005
4,4'-DDE	72-55-9	0.1	GCTL	0.033	0.02	0.01	0.005
4,4'-DDT	50-29-3	0.1	GCTL	0.033	0.02	0.01	0.005
ALDRIN	309-00-2	0.00021	Tapwater RSL	0.00007	0.02	0.01	0.0033
ALPHA-BHC	**319-84-6**	**0.006**	**GCTL**	**0.002**	**0.02**	**0.01**	**0.0033**

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
ALPHA-CHLORDANE[6]	5103-71-9	0.027	Tapwater RSL	0.063	0.02	0.01	0.0033
BETA-BHC	319-85-7	0.02	GCTL	0.0067	0.02	0.01	0.0033
DELTA-BHC	319-86-8	2.1	GCTL	0.7	0.02	0.01	0.0033
DIELDRIN	60-57-1	0.0015	Tapwater RSL	0.0005	0.02	0.01	0.005
ENDOSULFAN I[7]	959-98-8	7.8	Tapwater RSL	0.26	0.02	0.01	0.0033
ENDOSULFAN II[7]	33213-65-9	78	Tapwater RSL	0.26	0.02	0.01	0.005
ENDOSULFAN SULFATE[7]	1031-07-8	7.8	Tapwater RSL	0.26	0.02	0.01	0.005
ENDRIN[8]	72-20-8	0.17	Tapwater RSL	0.057	0.02	0.01	0.005
ENDRIN ALDEHYDE[8]	7421-93-4	0.17	Tapwater RSL	0.057	0.02	0.01	0.005
ENDRIN KETONE[8]	53494-70-5	0.17	Tapwater RSL	0.057	0.02	0.01	0.005
GAMMA-BHC (LINDANE)	58-89-9	0.036	Tapwater RSL	0.012	0.02	0.01	0.0033
GAMMA-CHLORDANE[6]	5103-74-2	0.027	Tapwater RSL	0.063	0.02	0.01	0.0033
HEPTACHLOR	76-44-8	0.0018	Tapwater RSL	0.0006	0.02	0.01	0.0033
HEPTACHLOR EPOXIDE	**1024-57-3**	**0.0033**	**Tapwater RSL**	**0.0011**	**0.02**	**0.01**	**0.0033**
METHOXYCHLOR	72-43-5	2.7	Tapwater RSL	0.9	0.02	0.01	0.0033
TOXAPHENE	8001-35-2	0.013	Tapwater RSL	0.0043	1	0.667	0.33
TCL PCBs							

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
AROCLOR-1016	12674-11-2	0.096	Tapwater RSL	0.037	0.5	0.25	0.125
AROCLOR-1221	11104-28-2	0.0043	Tapwater RSL	0.0014	0.5	0.25	0.125
AROCLOR-1232	11141-16-5	0.0043	Tapwater RSL	0.0014	0.5	0.25	0.125
AROCLOR-1242	53469-21-9	0.034	Tapwater RSL	0.011	0.5	0.25	0.125
AROCLOR-1248	12672-29-6	0.034	Tapwater RSL	0.011	0.5	0.25	0.125
AROCLOR-1254	11097-69-1	0.034	Tapwater RSL	0.01	0.5	0.25	0.125
AROCLOR-1260	11096-82-5	0.034	Tapwater RSL	0.011	0.5	0.25	0.125
TOTAL AROCLOR	1336-36-3	0.5	GCTL	0.17	3.5	1.75	0.875

Notes:

1) The value for hexavalent chromium is presented

2) The value presented is for Vanadium and compounds.

3) The value for 1,3-dichloropropene is presented.

4) The value for 4-nitroaniline is presented.

5) The value for pyrene is presented.

6) The value for Chlordane is presented.

7) The value for Endosulfan is presented.

8) The value for Endrin is presented.

* indicates that these compounds will be reported from a low level scan analysis.

Project Action Limits include:

- Federal Maximum Contaminant Levels (MCLs) per the 1974 Safe Drinking Water Act, amended in 1986 and 1996.
- Florida Maximum Contaminant Levels (MCLs) per Chapter 62-550, Florida Administrative Code (F.A.C.), Secondary Criteria (SMCL) and Primary Criteria (PMCL);

Chemical	Chemical Abstract Service (CAS) No.	Project Action Limit (PAL) (µg/L)	PAL Reference	Project Quantitation Limit Goal (PQLG) (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)

and Florida Groundwater Cleanup Target Levels (GCTLs) per Chapter 62-777, F.A.C.

- USEPA Regional Screening Levels (RSLs) (May, 2012) include Tap Water RSLs for noncarcinogens adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. The tap water RSL for carcinogens (not adjusted) is equivalent to an incremental lifetime cancer risk (ILCR) of 1E-6.

Bolded rows indicate that the PAL is between the laboratory LOQ and DL. The Partnering Team has agreed to accept this data for decision making if results below the LOQ are "J" qualified and the results are discussed in the monitoring report.

Shaded rows indicate the PAL is less than the DL; therefore, the Partnering Team has agreed to replace the PALs with the laboratory LOQs for decision making purposes, as suggested in “Guidance for the Selection of Analytical Methods for the Evaluation of Practical Quantitation Limits” (FDEP, 2004).

DOD QSM Version 4.2 Limits

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	300_	Chloride	0.500	0.33	0.170	mg/L	90-110	90	110	20	Standard	145	16887-00-6
Water	300_	Nitrate as N	0.25	0.10	0.0330	mg/L	90-110	90	110	20	Standard	145	14797-55-8
Water	300_	Nitrite as N	0.25	0.10	0.0330	mg/L	90-110	90	110	20	Standard	145	14797-65-0
Water	300_	Sulfate as SO4	2.5	1.0	0.330	mg/L	90-110	90	110	20	Standard	145	14808-79-8
Water	6010B/C	Aluminum	200	100	50.0	ug/L	80-120	80	120	20	QSM	100/105	7429-90-5
Water	6010B/C	Antimony	10	8.00	5.00	ug/L	80-120	80	120	20	QSM	100/105	7440-36-0
Water	6010B/C	Arsenic	10.0	6.00	3.00	ug/L	80-120	80	120	20	QSM	100/105	7440-38-2
Water	6010B/C	Barium	40.0	10.0	5.00	ug/L	80-120	80	120	20	QSM	100/105	7440-39-3
Water	6010B/C	Beryllium	5.00	2.00	1.00	ug/L	80-120	80	120	20	QSM	100/105	7440-41-7
Water	6010B/C	Cadmium	5.00	2.00	1.00	ug/L	80-120	80	120	20	QSM	100/105	7440-43-9
Water	6010B/C	Calcium	5000	2000	1000	ug/L	80-120	80	120	20	QSM	100/105	7440-70-2
Water	6010B/C	Chromium, total	10.0	4.00	2.00	ug/L	80-120	80	120	20	QSM	100/105	7440-47-3
Water	6010B/C	Cobalt	12.5	10.0	5.00	ug/L	80-120	80	120	20	QSM	100/105	7440-48-4
Water	6010B/C	Copper	10.0	8.00	4.00	ug/L	80-120	80	120	20	QSM	100/105	7440-50-8
Water	6010B/C	Iron	100	60.0	30.0	ug/L	80-120	80	120	20	QSM	100/105	7439-89-6
Water	6010B/C	Lead	3.00	3.00	1.50	ug/L	80-120	80	120	20	QSM	100/105	7439-92-1
Water	6010B/C	Magnesium	5000	3000	1000	ug/L	80-120	80	120	20	QSM	100/105	7439-95-4
Water	6010B/C	Manganese	15.0	6.00	3.00	ug/L	80-120	80	120	20	QSM	100/105	7439-96-5
Water	6010B/C	Molybdenum	20	10.0	5.00	ug/L	80-120	80	120	20	QSM	100/105	7439-98-7
Water	6010B/C	Nickel	10.0	6.00	3.00	ug/L	80-120	80	120	20	QSM	100/105	7440-02-0
Water	6010B/C	Potassium	5000	3000	1000	ug/L	80-120	80	120	20	QSM	100/105	7440-09-7
Water	6010B/C	Selenium	10	5.00	3.00	ug/L	80-120	80	120	20	QSM	100/105	7782-49-2
Water	6010B/C	Silver	10.0	2.00	1.00	ug/L	80-120	80	120	20	QSM	100/105	7440-22-4
Water	6010B/C	Sodium	5000	3000	1000	ug/L	80-120	80	120	20	QSM	100/105	7440-23-5
Water	6010B/C	Thallium	8.00	4.00	3.00	ug/L	80-120	80	120	20	QSM	100/105	7440-28-0
Water	6010B/C	Vanadium	12.5	10.0	5.00	ug/L	80-120	80	120	20	QSM	100/105	7440-62-2
Water	6010B/C	Zinc	20.0	10.0	5.00	ug/L	80-120	80	120	20	QSM	100/105	7440-66-6
Water	7470A	Mercury	0.20	0.20	0.0800	ug/L	80-120	80	120	20	QSM	103	7439-97-6
Water	8081A/B	4,4'-DDD	0.0200	0.0100	0.00500	ug/L	25-150	25	150	30	QSM	302/211	72-54-8
Water	8081A/B	4,4'-DDE	0.0200	0.0100	0.00500	ug/L	35-140	35	140	30	QSM	302/211	72-55-9
Water	8081A/B	4,4'-DDT	0.0200	0.0100	0.00500	ug/L	45-140	45	140	30	QSM	302/211	50-29-3
Water	8081A/B	Aldrin	0.0200	0.0100	0.00330	ug/L	25-140	25	140	30	QSM	302/211	309-00-2
Water	8081A/B	alpha-BHC (alpha-HCH)	0.0200	0.0100	0.00330	ug/L	60-130	60	130	30	QSM	302/211	319-84-6
Water	8081A/B	alpha-Chlordane	0.0200	0.0100	0.00330	ug/L	65-125	65	125	30	QSM	302/211	5103-71-9

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	8081A/B	beta-BHC (beta-HCH)	0.0200	0.0100	0.00330	ug/L	65-125	65	125	30	QSM	302/211	319-85-7
Water	8081A/B	delta-BHC (delta-HCH)	0.0200	0.0100	0.00330	ug/L	45-135	45	135	30	QSM	302/211	319-86-8
Water	8081A/B	Dieldrin	0.0200	0.0100	0.00500	ug/L	60-130	60	130	30	QSM	302/211	60-57-1
Water	8081A/B	Endosulfan I	0.0200	0.0100	0.00330	ug/L	50-110	50	110	30	QSM	302/211	959-98-8
Water	8081A/B	Endosulfan II	0.0200	0.0100	0.00500	ug/L	30-130	30	130	30	QSM	302/211	33213-65-9
Water	8081A/B	Endosulfan sulfate	0.0200	0.0100	0.00500	ug/L	55-155	55	155	30	QSM	302/211	1031-07-8
Water	8081A/B	Endrin	0.0200	0.0100	0.00500	ug/L	55-135	55	135	30	QSM	302/211	72-20-8
Water	8081A/B	Endrin aldehyde	0.0200	0.0100	0.00500	ug/L	55-135	55	135	30	QSM	302/211	7421-93-4
Water	8081A/B	Endrin ketone	0.0200	0.0100	0.00500	ug/L	75-125	75	125	30	QSM	302/211	53494-70-5
Water	8081A/B	gamma-BHC (Lindane; gamma-HCH)	0.0200	0.0100	0.00330	ug/L	25-135	25	135	30	QSM	302/211	58-89-9
Water	8081A/B	gamma-Chlordane	0.0200	0.0100	0.00330	ug/L	60-125	60	125	30	QSM	302/211	5103-74-2
Water	8081A/B	Heptachlor	0.0200	0.0100	0.00330	ug/L	40-130	40	130	30	QSM	302/211	76-44-8
Water	8081A/B	Heptachlor epoxide	0.0200	0.0100	0.00330	ug/L	60-130	60	130	30	QSM	302/211	1024-57-3
Water	8081A/B	Methoxychlor	0.0200	0.0100	0.00330	ug/L	55-150	55	150	30	QSM	302/211	72-43-5
Water	8081A/B	Toxaphene	1.00	0.667	0.330	ug/L	50-150	50	150	30	QSM	302/211	8001-35-2
Water	8082_/A	Aroclor-1016	0.500	0.250	0.125	ug/L	25-145	25	145	30	QSM	302/211	12674-11-2
Water	8082_/A	Aroclor-1221	0.500	0.250	0.125	ug/L	50-150 (if spiked)	50	150	30	QSM	302/211	11104-28-2
Water	8082_/A	Aroclor-1232	0.500	0.250	0.125	ug/L	50-150 (if spiked)	50	150	30	QSM	302/211	11141-16-5
Water	8082_/A	Aroclor-1242	0.500	0.250	0.125	ug/L	50-150 (if spiked)	50	150	30	QSM	302/211	53469-21-9
Water	8082_/A	Aroclor-1248	0.500	0.250	0.125	ug/L	50-150 (if spiked)	50	150	30	QSM	302/211	12672-29-6
Water	8082_/A	Aroclor-1254	0.500	0.250	0.125	ug/L	50-150 (if spiked)	50	150	30	QSM	302/211	11097-69-1
Water	8082_/A	Aroclor-1260	0.500	0.250	0.125	ug/L	30-145	30	145	30	QSM	302/211	11096-82-5
Water	8260B	1,1,1,2-Tetrachloroethane	1.00	0.50	0.25	ug/L	80-130	80	130	30	QSM	202	630-20-6
Water	8260B	1,1,1-Trichloroethane (1,1,1-TCA)	1.00	0.50	0.25	ug/L	65-130	65	130	30	QSM	202	71-55-6
Water	8260B	1,1,2,2-Tetrachloroethane	1.00	0.50	0.25	ug/L	65-130	65	130	30	QSM	202	79-34-5
Water	8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	2.00	1.00	0.50	ug/L	60-130	60	130	30	Standard	202	76-13-1

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	8260B	1,1,2-Trichloroethane	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	79-00-5
Water	8260B	1,1-Dichloroethane (1,1-DCA)	1.00	0.50	0.25	ug/L	70-135	70	135	30	QSM	202	79-34-3
Water	8260B	1,1-Dichloroethene (1,1-DCE)	1.00	0.50	0.25	ug/L	70-130	70	130	30	QSM	202	75-35-4
Water	8260B	1,1-Dichloropropene	1.00	0.50	0.25	ug/L	75-130	75	130	30	QSM	202	563-58-6
Water	8260B	1,2,3-Trichlorobenzene	1.00	0.50	0.25	ug/L	55-140	55	140	30	QSM	202	87-61-6
Water	8260B	1,2,3-Trichloropropane	2.00	1.00	0.50	ug/L	75-125	75	125	30	QSM	202	96-18-4
Water	8260B	1,2,4-Trichlorobenzene	1.00	0.50	0.25	ug/L	65-135	65	135	30	QSM	202	120-82-1
Water	8260B	1,2,4-Trimethylbenzene	1.00	0.50	0.25	ug/L	75-130	75	130	30	QSM	202	95-63-6
Water	8260B	1,2-Dibromo-3-chloropropane (DBCP)	2.00	1.00	0.50	ug/L	50-130	50	130	30	QSM	202	96-12-8
Water	8260B	1,2-Dibromoethane (EDB)	1.00	0.50	0.25	ug/L	80-120	80	120	30	QSM	202	106-93-4
Water	8260B	1,2-Dichlorobenzene	1.00	0.50	0.25	ug/L	70-120	70	120	30	QSM	202	95-50-1
Water	8260B	1,2-Dichloroethane (EDC)	1.00	0.50	0.25	ug/L	70-130	70	130	30	QSM	202	107-06-2
Water	8260B	1,2-Dichloroethane-d4	30	0.50	0.25	ug/L	70-120	70	120	30	Surr	202	17060-07-0
Water	8260B	1,2-Dichloroethene (Total)	2.00	1.00	0.50	ug/L	60-140	60	140	30	Standard	202	540-59-0
Water	8260B	1,2-Dichloropropane	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	78-87-5
Water	8260B	1,3,5-Trimethylbenzene	1.00	0.50	0.25	ug/L	75-130	75	130	30	QSM	202	108-67-8
Water	8260B	1,3-Dichlorobenzene	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	541-73-1
Water	8260B	1,3-Dichloropropane	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	142-28-9
Water	8260B	1,4-Dichlorobenzene	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	106-46-7
Water	8260B	2,2-Dichloropropane	1.00	0.50	0.25	ug/L	70-135	70	135	30	QSM	202	594-20-7
Water	8260B	2-Butanone (Methyl ethyl ketone; MEK)	10.0	5.00	2.50	ug/L	30-150	30	150	30	QSM	202	78-93-3
Water	8260B	2-Chlorotoluene	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	95-49-8
Water	8260B	2-Hexanone (Methyl butyl ketone; MBK)	5.00	2.50	1.25	ug/L	55-130	55	130	30	QSM	202	591-78-6
Water	8260B	4-Chlorotoluene	1.00	0.50	0.25	ug/L	75-130	75	130	30	QSM	202	106-34-4
Water	8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	5.00	2.50	1.25	ug/L	60-135	60	135	30	QSM	202	108-10-1
Water	8260B	Acetone	10.0	5.00	2.50	ug/L	40-140	40	140	30	QSM	202	67-64-1
Water	8260B	Benzene	1.00	0.50	0.25	ug/L	80-120	80	120	30	QSM	202	71-43-2
Water	8260B	Bromobenzene	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	108-86-1
Water	8260B	Bromochloromethane	1.00	0.50	0.25	ug/L	65-130	65	130	30	QSM	202	74-97-5
Water	8260B	Bromodichloromethane (Dibromochloromethane)	1.00	0.50	0.25	ug/L	75-120	75	120	30	QSM	202	75-27-4

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	8270C/D	2.4.6-Tribromophenol	10	5	2.5	ug/L	40-125	40	125		Surr	301/201	118-79-6
Water	8260B	Bromoform	1.00	0.50	0.25	ug/L	70-130	70	130	30	QSM	202	75-25-2
Water	8260B	Bromomethane	2.00	1.00	0.50	ug/L	30-145	30	145	30	QSM	202	74-83-9
Water	8260B	Carbon Disulfide	1.00	0.50	0.25	ug/L	35-160	35	160	30	QSM	202	75-15-0
Water	8260B	Carbon Tetrachloride	1.00	0.50	0.25	ug/L	65-140	65	140	30	QSM	202	56-23-5
Water	8260B	Chlorobenzene	1.00	0.50	0.25	ug/L	80-120	80	120	30	QSM	202	108-90-7
Water	8260B	Chloroethane	2.00	1.00	0.50	ug/L	60-135	60	135	30	QSM	202	75-00-3
Water	8260B	Chloroform	1.00	0.50	0.25	ug/L	65-135	65	135	30	QSM	202	67-66-3
Water	8260B	Chloromethane	1.00	0.50	0.25	ug/L	40-125	40	125	30	QSM	202	74-87-3
Water	8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)	1.00	0.50	0.25	ug/L	70-125	70	125	30	QSM	202	156-59-2
Water	8260B	cis-1,3-Dichloropropene	1.00	0.50	0.25	ug/L	70-130	70	130	30	QSM	202	10061-01-5
Water	8260B	Cyclohexane	1.00	0.50	0.25	ug/L	60-130	60	130	30	Standard	202	110-82-7
Water	8260B	Dibromochloromethane (Chlorodibromomethane)	1.00	0.50	0.25	ug/L	60-135	60	135	30	QSM	202	124-48-1
Water	8260B	Dibromofluoromethane	30	0.50	0.25	ug/L	85-115	85	115	30	Surr	202	85-115
Water	8260B	Dibromomethane	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	74-95-3
Water	8260B	Dichlorodifluoromethane (CFC-12)	2.00	1.00	0.50	ug/L	30-155	30	155	30	QSM	202	75-71-8
Water	8260B	Ethylbenzene	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	100-41-4
Water	8260B	Hexachlorobutadiene	1.00	0.50	0.25	ug/L	50-140	50	140	30	QSM	202	87-68-3
Water	8260B	Isopropylbenzene (Cumene)	1.00	0.50	0.25	ug/L	75-125	75	125	30	QSM	202	98-82-8
Water	8260B	m,p-Xylene	2.00	1.00	0.50	ug/L	75-130	75	130	30	QSM	202	108-38-3/1
Water	8260B	Methyl Acetate	2.00	1.00	0.50	ug/L	55-150	55	150	30	Standard	202	79-20-9
Water	8260B	Methyl Tertiary Butyl Ether (MTBE)	1.00	0.50	0.25	ug/L	65-125	65	125	30	QSM	202	1634-04-4
Water	8260B	Methylcyclohexane	1.00	0.50	0.25	ug/L	60-125	60	125	30	Standard	202	108-87-2
Water	8260B	Methylene Chloride, or Dichloromethane	2.00	1.00	0.50	ug/L	55-140	55	140	30	QSM	202	75-09-2
Water	8260B	Naphthalene	1.00	0.50	0.25	ug/L	55-140	55	140	30	QSM	202	91-20-3
Water	8260B	n-Butylbenzene	1.00	0.50	0.25	ug/L	70-135	70	135	30	QSM	202	104-51-8
Water	8260B	n-Propylbenzene	1.00	0.50	0.25	ug/L	70-130	70	130	30	QSM	202	103-65-1
Water	8260B	o-Xylene	1.00	0.50	0.25	ug/L	80-120	80	120	30	QSM	202	95-47-6
Water	8260B	p-Isopropyltoluene	1.00	0.50	0.25	ug/L	75-130	75	130	30	QSM	202	99-87-6
Water	8260B	sec-Butylbenzene	1.00	0.50	0.25	ug/L	70-125	70	125	30	QSM	202	135-98-8
Water	8260B	Styrene	1.00	0.50	0.25	ug/L	65-135	65	135	30	QSM	202	100-42-5

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	8260B	tert-Butylbenzene	1.00	0.50	0.25	ug/L	70-130	70	130	30	QSM	202	98-06-6
Water	8260B	Tetrachloroethene (PCE; PERC)	1.00	0.50	0.25	ug/L	45-150	45	150	30	QSM	202	127-18-4
Water	8260B	Toluene	1.00	0.50	0.25	ug/L	75-120	75	120	30	QSM	202	108-88-3
Water	8260B	Toluene-d8	30	1.00	0.50	ug/L	85-120	85	120	30	Surr	202	85-120
Water	8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)	1.00	0.50	0.25	ug/L	60-140	60	140	30	QSM	202	156-60-5
Water	8260B	trans-1,3-Dichloropropene	1.00	0.50	0.25	ug/L	55-140	55	140	30	QSM	202	10061-02-6
Water	8260B	Trichloroethene (TCE)	1.00	0.50	0.25	ug/L	70-125	70	125	30	QSM	202	79-01-6
Water	8260B	Trichlorofluoromethane (CFC-11)	2.00	1.00	0.50	ug/L	60-145	60	145	30	QSM	202	75-69-4
Water	8260B	Vinyl Chloride (VC)	1.00	0.50	0.25	ug/L	50-145	50	145	30	QSM	202	75-01-4
Water	8260B	Xylenes (total)	3.00	1.50	0.75	ug/L	75-130	75	130	30	Standard	202	1330-20-7
Water	8270C/D	1,1'-Biphenyl	5.00	2.50	1.25	ug/L	50-110	50	110	30	Standard	301/201	92-52-4
Water	8270C/D	1,2,4,5-Tetrachlorobenzene	5.00	2.50	1.25	ug/L	50-125	50	125	30	Standard	301/201	95-94-3
Water	8270C/D	1,2,4-Trichlorobenzene	5.00	2.50	1.25	ug/L	35-105	35	105	30	QSM	301/201	120-82-1
Water	8270C/D	1,2-Dichlorobenzene (DCB)	5.00	2.50	1.25	ug/L	35-100	35	100	30	QSM	301/201	95-50-1
Water	8270C/D	1,2-Diphenylhydrazine	5.00	2.50	1.25	ug/L	55-115	55	115	30	QSM	301/201	122-66-7
Water	8270C/D	1,3-Dichlorobenzene (DCB)	5.00	2.50	1.25	ug/L	30-100	30	100	30	QSM	301/201	541-73-1
Water	8270C/D	1,4-Dichlorobenzene (DCB)	5.00	2.50	1.25	ug/L	30-100	30	100	30	QSM	301/201	106-46-7
Water	8270C/D	1-Methylnaphthalene	5.00	2.50	1.25	ug/L	30-115	30	115	30	QSM	301/201	90-12-0
Water	8270C/D	2,3,4,6-Tetrachlorophenol	10.0	5.00	2.50	ug/L	50-125	50	125	30	Standard	301/201	58-90-2
Water	8270C/D	2,4,5-Trichlorophenol	5.00	2.50	1.25	ug/L	50-110	50	110	30	QSM	301/201	95-95-4
Water	8270C/D	2,4,6-Trichlorophenol (TCP)	5.00	2.50	1.25	ug/L	50-115	50	115	30	QSM	301/201	88-06-2
Water	8270C/D	2,4-Dichlorophenol (DCP)	5.00	2.50	1.25	ug/L	40-110	40	110	30	QSM	301/201	120-83-2
Water	8270C/D	2,4-Dimethylphenol	20.0	10.0	5.00	ug/L	30-110	30	110	30	QSM	301/201	105-67-9
Water	8270C/D	2,4-Dinitrophenol	50.0	25.0	8.33	ug/L	15-140	15	140	30	QSM	301/201	51-28-5
Water	8270C/D	2,4-Dinitrotoluene (DNT)	5.00	2.50	1.25	ug/L	50-120	50	120	30	QSM	301/201	121-14-2
Water	8270C/D	2,6-Dinitrotoluene	5.00	2.50	1.25	ug/L	50-115	50	115	30	QSM	301/201	606-20-2
Water	8270C/D	2-Fluorobiphenyl	5.00	2.50	1.25	ug/L	50-110	50	110		Surr	301/201	321-60-8
Water	8270C/D	2-Chloronaphthalene	5.00	2.50	1.25	ug/L	50-105	50	105	30	QSM	301/201	91-58-7
Water	8270C/D	2-Chlorophenol	5.00	2.50	1.25	ug/L	35-105	35	105	30	QSM	301/201	95-57-8
Water	8270C/D low	2-Fluorobiphenyl	0.200	0.100	0.0500	ug/L	34-167	34	167		Surr	343/201	321-60-8

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	8270C/D	2-Fluorophenol	10	5	2.5	ug/L	20-110	20	110		Surr	301/201	367-12-4
Water	8270C/D	2-Methylnaphthalene	5.00	2.50	1.25	ug/L	45-105	45	105	30	QSM	301/201	91-57-6
Water	8270C/D	2-Methylphenol (o-Cresol)	5.00	2.50	1.25	ug/L	40-110	40	110	30	QSM	301/201	95-48-7
Water	8270C/D	2-Nitroaniline	20.0	10.0	5.00	ug/L	50-115	50	115	30	QSM	301/201	88-74-4
Water	8270C/D	2-Nitrophenol (ONP)	5.00	2.50	1.25	ug/L	40-115	40	115	30	QSM	301/201	88-75-5
Water	8270C/D	3,3'-Dichlorobenzidine (DCB)	5.00	2.50	1.25	ug/L	20-110	20	110	30	QSM	301/201	91-94-1
Water	8270C/D	3-Methylphenol/4-Methylphenol	5.00	2.50	1.25	ug/L	30-110	30	110	30	QSM	301/201	108-39-4/106
Water	8270C/D	3-Nitroaniline	20.0	10.0	5.00	ug/L	20-125	20	125	30	QSM	301/201	100-01-6
Water	8270C/D	4,6-Dinitro-2-methylphenol (DNOC)	20.0	10.0	5.00	ug/L	40-130	40	130	30	QSM	301/201	534-52-1
Water	8270C/D	4-Bromophenyl phenyl ether	5.00	2.50	1.25	ug/L	50-115	50	115	30	QSM	301/201	101-55-3
Water	8270C/D	4-Chloro-3-methylphenol	5.00	2.50	1.25	ug/L	45-110	45	110	30	QSM	301/201	59-50-7
Water	8270C/D	4-Chloroaniline	5.00	2.50	1.25	ug/L	15-110	15	110	30	QSM	301/201	106-47-8
Water	8270C/D	4-Chlorophenyl phenyl ether	5.00	2.50	1.25	ug/L	50-110	50	110	30	QSM	301/201	7005-72-3
Water	8270C/D	4-Nitroaniline (PNA)	20.0	10.0	5.00	ug/L	35-120	35	120	30	QSM	301/201	100-01-6
Water	8270C/D	4-Nitrophenol (PNP)	20.0	10.0	5.00	ug/L	0-125	0	125	30	QSM	301/201	100-02-7
Water	8270C/D	Acenaphthene	5.00	2.50	1.25	ug/L	45-110	45	110	30	QSM	301/201	83-32-9
Water	8270C/D	Acenaphthylene	5.00	2.50	1.25	ug/L	50-105	50	105	30	QSM	301/201	208-96-8
Water	8270C/D	Acetophenone	5.00	2.50	1.25	ug/L	50-110	50	110	30	Standard	301/201	98-86-2
Water	8270C/D	Anthracene	5.00	2.50	1.25	ug/L	55-110	55	110	30	QSM	301/201	120-12-7
Water	8270C/D	Atrazine	5.00	2.50	1.25	ug/L	70-115	70	115	30	Standard	301/201	1912-24-9
Water	8270C/D	Benzaldehyde	5.00	2.50	1.25	ug/L	10-180	10	180	30	Standard	301/201	100-52-7
Water	8270C/D	Benzo(a)anthracene	5.00	2.50	1.25	ug/L	55-110	55	110	30	QSM	301/201	56-55-3
Water	8270C/D	Benzo(a)pyrene	5.00	2.50	1.25	ug/L	55-110	55	110	30	QSM	301/201	50-32-8
Water	8270C/D	Benzo(b)fluoranthene	5.00	2.50	1.25	ug/L	45-120	45	120	30	QSM	301/201	205-99-2
Water	8270C/D	Benzo(g,h,i)perylene	5.00	2.50	1.25	ug/L	40-125	40	125	30	QSM	301/201	191-24-2
Water	8270C/D	Benzo(k)fluoranthene	5.00	2.50	1.25	ug/L	45-125	45	125	30	QSM	301/201	207-08-9
Water	8270C/D	Benzoic Acid	100	50.0	25.0	ug/L	0-125	0	125	30	QSM	301/201	65-85-0
Water	8270C/D	Benzyl alcohol	5.00	2.50	1.25	ug/L	30-110	30	110	30	QSM	301/201	100-51-6
Water	8270C/D	bis(2-Chloroethoxy)methane	5.00	2.50	1.25	ug/L	45-105	45	105	30	QSM	301/201	111-91-1
Water	8270C/D	bis(2-Chloroethyl)ether (BCEE)	5.00	2.50	1.25	ug/L	35-110	35	110	30	QSM	301/201	111-44-4

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	5.00	2.50	1.25	ug/L	25-130	25	130	30	QSM	301/201	108-60-1
Water	8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)	5.00	2.50	1.25	ug/L	40-125	40	125	30	QSM	301/201	117-81-7
Water	8270C/D	Butyl benzyl phthalate (BBP)	5.00	2.50	1.25	ug/L	45-115	45	115	30	QSM	301/201	85-68-7
Water	8270C/D	Caprolactam	5.00	2.50	1.25	ug/L	20-110	20	110	30	Standard	301/201	105-60-2
Water	8270C/D	Carbazole	5.00	2.50	1.25	ug/L	50-115	50	115	30	QSM	301/201	86-74-8
Water	8270C/D	Chrysene	5.00	2.50	1.25	ug/L	55-110	55	110	30	QSM	301/201	218-01-9
Water	8270C/D	Dibenz(a,h)anthracene	5.00	2.50	1.25	ug/L	40-125	40	125	30	QSM	301/201	53-70-3
Water	8270C/D	Dibenzofuran (DBF)	5.00	2.50	1.25	ug/L	55-105	55	105	30	QSM	301/201	132-64-9
Water	8270C/D	Diethyl phthalate (DEP)	5.00	2.50	1.25	ug/L	40-120	40	120	30	QSM	301/201	84-66-2
Water	8270C/D	Dimethyl phthalate (DMP)	5.00	2.50	1.25	ug/L	25-125	25	125	30	QSM	301/201	131-11-3
Water	8270C/D	Di-n-butyl phthalate (DBP)	5.00	2.50	1.25	ug/L	55-115	55	115	30	QSM	301/201	84-74-2
Water	8270C/D	Di-n-octyl phthalate (DNOP)	5.00	2.50	1.25	ug/L	35-135	35	135	30	QSM	301/201	117-84-0
Water	8270C/D	Fluoranthene	5.00	2.50	1.25	ug/L	55-115	55	115	30	QSM	301/201	206-44-0
Water	8270C/D	Fluorene	5.00	2.50	1.25	ug/L	50-110	50	110	30	QSM	301/201	86-73-7
Water	8270C/D	Hexachlorobenzene (HCB)	5.00	2.50	1.25	ug/L	50-110	50	110	30	QSM	301/201	118-74-1
Water	8270C/D	Hexachlorobutadiene (HCBD)	5.00	2.50	1.25	ug/L	25-105	25	105	30	QSM	301/201	87-68-3
Water	8270C/D	Hexachlorocyclopentadiene (HCCPD)	10.0	5.00	2.50	ug/L	10-110	10	110	30	Standard	301/201	77-47-4
Water	8270C/D	Hexachloroethane (HCE)	5.00	2.50	1.25	ug/L	30-95	30	95	30	QSM	301/201	67-72-1
Water	8270C/D	Indeno(1,2,3-cd)pyrene	5.00	2.50	1.25	ug/L	45-125	45	125	30	QSM	301/201	193-39-5
Water	8270C/D	Isophorone	5.00	2.50	1.25	ug/L	50-110	50	110	30	QSM	301/201	78-59-1
Water	8270C/D	Naphthalene	5.00	2.50	1.25	ug/L	40-100	40	100	30	QSM	301/201	91-20-3
Water	8270C/D	Nitrobenzene	5.00	2.50	1.25	ug/L	30-110	30	110	30	QSM	301/201	98-95-3
Water	8260B	Bromofluorobenzene	30	0.50	0.25	ug/L	75-120	75	120	30	Surr	202	460-00-4
Water	8270C/D	N-Nitrosodimethylamine	5.00	2.50	1.25	ug/L	25-110	25	110	30	QSM	301/201	86-30-6
Water	8270C/D	N-Nitroso-di-n-propylamine (NDPA)	5.00	2.50	1.25	ug/L	35-130	35	130	30	QSM	301/201	621-64-7
Water	8270C/D	N-nitrosodiphenylamine (NDPHA)	5.00	2.50	1.25	ug/L	50-110	50	110	30	QSM	301/201	86-30-6
Water	8270C/D	Pentachlorophenol	20.0	10.0	5.00	ug/L	40-115	40	115	30	QSM	301/201	87-86-5
Water	8270C/D	Phenanthrene	5.00	2.50	1.25	ug/L	50-115	50	115	30	QSM	301/201	85-01-8
Water	8270C/D	Phenol	5.00	2.50	1.25	ug/L	0-115	0	115	30	QSM	301/201	108-95-2

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	8270C/D	Nitrobenzene-d5	5	2.5	1.25	ug/L	40-110	40	110		Surr	301/201	4165-60-0
Water	8270C/D	Pyrene	5.00	2.50	1.25	ug/L	50-130	50	130	30	QSM	301/201	129-00-0
Water	8270C/D	Phenol-d6	10	5	2.5	ug/L	0-110	0	110		Surr	301/201	13127-88-3
Water	8270C/D	Terphenyl-d14	5	2.5	1.25	ug/L	50-135	50	135		Surr	301/201	1718-51-0
Water	8270C/D low	Terphenyl-d14	0.200	0.100	0.0500	ug/L	34-167	34	167		Surr	343/201	1718-51-0
Water	8270C/D low	1-Methylnaphthalene	0.200	0.100	0.0500	ug/L	35-131	35	131	30	QSM	301/201	90-12-0
Water	8270C/D low	2-Methylnaphthalene	0.200	0.100	0.0500	ug/L	36-121	36	121	30	QSM	301/201	91-57-6
Water	8270C/D low	Acenaphthene	0.200	0.100	0.0500	ug/L	41-132	41	132	30	QSM	301/201	83-32-9
Water	8270C/D low	Acenaphthylene	0.200	0.100	0.0500	ug/L	43-140	43	140	30	QSM	301/201	208-96-8
Water	8270C/D low	Anthracene	0.200	0.100	0.0500	ug/L	50-139	50	139	30	QSM	301/201	120-12-7
Water	8270C/D low	Benzo(a)anthracene	0.200	0.100	0.0500	ug/L	58-141	58	141	30	QSM	301/201	56-55-3
Water	8270C/D low	Benzo(a)pyrene	0.200	0.100	0.0500	ug/L	31-142	31	142	30	QSM	301/201	50-32-8
Water	8270C/D low	Benzo(b)fluoranthene	0.200	0.100	0.0500	ug/L	42-156	42	156	30	QSM	301/201	205-99-2
Water	8270C/D low	Benzo(g,h,i)perylene	0.200	0.100	0.0500	ug/L	12-171	12	171	30	QSM	301/201	191-24-2
Water	8270C/D low	Benzo(k)fluoranthene	0.200	0.100	0.0500	ug/L	49-165	49	165	30	QSM	301/201	207-08-9
Water	8270C/D low	Chrysene	0.200	0.100	0.0500	ug/L	51-155	51	155	30	QSM	301/201	218-01-9
Water	8270C/D low	Dibenz (a,h) anthracene	0.200	0.100	0.0500	ug/L	28-153	28	153	30	QSM	301/201	53-70-3
Water	8270C/D low	Fluoranthene	0.200	0.100	0.0500	ug/L	47-158	47	158	30	QSM	301/201	206-44-0
Water	8270C/D low	Fluorene	0.200	0.100	0.0500	ug/L	40-140	40	140	30	QSM	301/201	86-73-7
Water	8270C/D low	Indeno (1,2,3-cd) pyrene	0.200	0.100	0.0500	ug/L	20-167	20	167	30	QSM	301/201	193-39-5
Water	8270C/D low	Naphthalene	0.200	0.100	0.0500	ug/L	39-125	39	125	30	QSM	301/201	91-20-3
Water	8270C/D low	Phenanthrene	0.400	0.200	0.100	ug/L	46-144	46	144	30	QSM	301/201	85-01-8
Water	8270C/D low	Pyrene	0.200	0.100	0.0500	ug/L	39-158	39	158	30	QSM	301/201	129-00-0
Water	EPA 410.4	Chemical Oxygen Demand	60	40	20	mg/L	80-120	80	120	20		163	NA

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Water	SM 2320B 20th/21st	Alkalinity, Total (as CACO3)	1.00	NA	1.00	mg/L	80-120	80	120	20		154	471-34-1
Water	SM5210B	Biochemical Oxygen Demand	2	2	2	mg/L	85-115	85	115	20		169	NA
S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Solid	6010B/C	Aluminum	40.0	20.0	10.0	mg/Kg	80-120	80	120	20	QSM	100/105	7429-90-5
Solid	6010B/C	Antimony	2.00	1.60	1.00	mg/Kg	80-120	80	120	20	QSM	100/105	7440-36-0
Solid	6010B/C	Arsenic	2.00	1.20	0.600	mg/Kg	80-120	80	120	20	QSM	100/105	7440-38-2
Solid	6010B/C	Barium	8.00	4	1.00	mg/Kg	80-120	80	120	20	QSM	100/105	7440-39-3
Solid	6010B/C	Beryllium	1.00	0.400	0.200	mg/Kg	80-120	80	120	20	QSM	100/105	7440-41-7
Solid	6010B/C	Cadmium	1	0.400	0.200	mg/Kg	80-120	80	120	20	QSM	100/105	7440-43-9
Solid	6010B/C	Calcium	1000	400	200	mg/Kg	80-120	80	120	20	QSM	100/105	7440-70-2
Solid	6010B/C	Chromium, total	2.00	0.800	0.400	mg/Kg	80-120	80	120	20	QSM	100/105	7440-47-3
Solid	6010B/C	Cobalt	2.50	2.00	1.00	mg/Kg	80-120	80	120	20	QSM	100/105	7440-48-4
Solid	6010B/C	Copper	2.00	1.60	0.800	mg/Kg	80-120	80	120	20	QSM	100/105	7440-50-8
Solid	6010B/C	Iron	20.0	12.0	6.00	mg/Kg	80-120	80	120	20	QSM	100/105	7439-89-6
Solid	6010B/C	Lead	1	0.600	0.300	mg/Kg	80-120	80	120	20	QSM	100/105	7439-92-1
Solid	6010B/C	Magnesium	1000	600	200	mg/Kg	80-120	80	120	20	QSM	100/105	7439-95-4
Solid	6010B/C	Manganese	3.00	1.20	0.600	mg/Kg	80-120	80	120	20	QSM	100/105	7439-96-5
Solid	6010B/C	Molybdenum	4	2.00	1.00	mg/Kg	80-120	80	120	20	QSM	100/105	7439-98-7
Solid	6010B/C	Nickel	2.00	1.20	0.600	mg/Kg	80-120	80	120	20	QSM	100/105	7440-02-0
Solid	6010B/C	Potassium	1000	600	200	mg/Kg	80-120	80	120	20	QSM	100/105	7440-09-7
Solid	6010B/C	Selenium	2	1.00	0.600	mg/Kg	80-120	80	120	20	QSM	100/105	7782-49-2
Solid	6010B/C	Silver	2.00	0.400	0.200	mg/Kg	80-120	80	120	20	QSM	100/105	7440-22-4
Solid	6010B/C	Sodium	1000	600	200	mg/Kg	80-120	80	120	20	QSM	100/105	7440-23-5
Solid	6010B/C	Thallium	1.60	0.800	0.600	mg/Kg	80-120	80	120	20	QSM	100/105	7440-28-0
Solid	6010B/C	Vanadium	2.50	2.00	1.00	mg/Kg	80-120	80	120	20	QSM	100/105	7440-62-2
Solid	6010B/C	Zinc	4.00	2.00	1.00	mg/Kg	80-120	80	120	20	QSM	100/105	7440-66-6
Solid	7471A/B	Mercury	0.033	0.033	0.0130	mg/Kg	80-120	80	120	20	QSM	104	7439-97-6
Solid	8082_/A	Aroclor-1016	16.7	8.33	4.17	ug/Kg	40-140	40	140	30	QSM	343/211	12674-11-2
Solid	8082_/A	Aroclor-1221	16.7	8.33	4.17	ug/Kg	50-150 (if spiked)	50	150	30	QSM	343/211	11104-28-2
Solid	8082_/A	Aroclor-1232	16.7	8.33	4.17	ug/Kg	50-150 (if	50	150	30	QSM	343/211	11141-16-5

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
							spiked)						
Solid	8082_/A	Aroclor-1242	16.7	8.33	4.17	ug/Kg	50-150 (if spiked)	50	150	30	QSM	343/211	53469-21-9
Solid	8082_/A	Aroclor-1248	16.7	8.33	4.17	ug/Kg	50-150 (if spiked)	50	150	30	QSM	343/211	12672-29-6
Solid	8082_/A	Aroclor-1254	16.7	8.33	4.17	ug/Kg	50-150 (if spiked)	50	150	30	QSM	343/211	11097-69-1
Solid	8082_/A	Aroclor-1260	16.7	8.33	4.17	ug/Kg	60-130	60	130	30	QSM	343/211	11096-82-5
Solid	8260B	1,1,1,2-Tetrachloroethane	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	630-20-6
Solid	8260B	1,1,1-Trichloroethane (1,1,1-TCA)	5.00	2.50	1.25	ug/Kg	70-135	70	135	30	QSM	225/202	71-55-6
Solid	8260B	1,1,2,2-Tetrachloroethane	5.00	2.50	1.25	ug/Kg	55-130	55	130	30	QSM	225/202	79-34-5
Solid	8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	10.0	5.00	2.50	ug/Kg	20-185	20	185	30	Standard	225/202	76-13-1
Solid	8260B	1,1,2-Trichloroethane	5.00	2.50	1.25	ug/Kg	60-125	60	125	30	QSM	225/202	79-00-5
Solid	8260B	1,1-Dichloroethane (1,1-DCA)	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	79-34-3
Solid	8260B	1,1-Dichloroethene (1,1-DCE)	5.00	2.50	1.25	ug/Kg	65-135	65	135	30	QSM	225/202	75-35-4
Solid	8260B	1,1-Dichloropropene	5.00	2.50	1.25	ug/Kg	70-135	70	135	30	QSM	225/202	563-58-6
Solid	8260B	1,2,3-Trichlorobenzene	5.00	2.50	1.25	ug/Kg	60-130	60	130	30	QSM	225/202	87-61-6
Solid	8260B	1,2,3-Trichloropropane	5.00	2.50	1.25	ug/Kg	65-130	65	130	30	QSM	225/202	96-18-4
Solid	8260B	1,2,4-Trichlorobenzene	5.00	2.50	1.25	ug/Kg	65-130	65	130	30	QSM	225/202	120-82-1
Solid	8260B	1,2,4-Trimethylbenzene	5.00	2.50	1.25	ug/Kg	65-135	65	135	30	QSM	225/202	95-63-6
Solid	8260B	1,2-Dibromo-3-chloropropane (DBCP)	10.0	5.00	2.50	ug/Kg	40-135	40	135	30	QSM	225/202	96-12-8
Solid	8260B	1,2-Dibromoethane (EDB)	5.00	2.50	1.25	ug/Kg	70-125	70	125	30	QSM	225/202	106-93-4
Solid	8260B	1,2-Dichlorobenzene	5.00	2.50	1.25	ug/Kg	75-120	75	120	30	QSM	225/202	95-50-1
Solid	8260B	1,2-Dichloroethane (EDC)	5.00	2.50	1.25	ug/Kg	70-135	70	135	30	QSM	225/202	107-06-2
Solid	8260B	1,2-Dichloroethane-d4	30	2.5	1.25	ug/Kg	75-140	75	140	30	Surr	225/202	17060-07-0
Solid	8260B	1,2-Dichloroethene (Total)	10.0	5.00	2.50	ug/Kg	65-135	65	135	30	Standard	225/202	540-59-0
Solid	8260B	1,2-Dichloropropane	5.00	2.50	1.25	ug/Kg	70-120	70	120	30	QSM	225/202	78-87-5
Solid	8260B	1,3,5-Trimethylbenzene	5.00	2.50	1.25	ug/Kg	65-135	65	135	30	QSM	225/202	108-67-8
Solid	8260B	1,3-Dichlorobenzene	5.00	2.50	1.25	ug/Kg	70-125	70	125	30	QSM	225/202	541-73-1
Solid	8260B	1,3-Dichloropropane	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	142-28-9

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Solid	8260B	1,4-Dichlorobenzene	5.00	2.50	1.25	ug/Kg	70-125	70	125	30	QSM	225/202	106-46-7
Solid	8260B	2,2-Dichloropropane	5.00	2.50	1.25	ug/Kg	65-135	65	135	30	QSM	225/202	594-20-7
Solid	8260B	2-Butanone (Methyl ethyl ketone; MEK)	10.0	5.00	2.50	ug/Kg	30-160	30	160	30	QSM	225/202	78-93-3
Solid	8260B	2-Chlorotoluene	5.00	2.50	1.25	ug/Kg	70-130	70	130	30	QSM	225/202	95-49-8
Solid	8260B	2-Hexanone (Methyl butyl ketone; MBK)	10.0	5.00	2.50	ug/Kg	45-145	45	145	30	QSM	225/202	591-78-6
Solid	8260B	4-Chlorotoluene	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	106-34-4
Solid	8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	10.0	5.00	2.50	ug/Kg	45-145	45	145	30	QSM	225/202	108-10-1
Solid	8260B	Acetone	20.0	10.0	5.00	ug/Kg	20-160	20	160	30	QSM	225/202	67-64-1
Solid	8260B	Benzene	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	71-43-2
Solid	8260B	Bromobenzene	5.00	2.50	1.25	ug/Kg	65-120	65	120	30	QSM	225/202	108-86-1
Solid	8260B	Bromochloromethane	5.00	2.50	1.25	ug/Kg	70-125	70	125	30	QSM	225/202	74-97-5
Solid	8260B	Bromodichloromethane (Dibromochloromethane)	5.00	2.50	1.25	ug/Kg	70-130	70	130	30	QSM	225/202	75-27-4
Solid	8270C/D	2.4.6-Tribromophenol	667	333	167	ug/Kg	35-125	35	125		Surr	343/201	118-79-6
Solid	8260B	Bromoform	5.00	2.50	1.25	ug/Kg	55-135	55	135	30	QSM	225/202	75-25-2
Solid	8260B	Bromomethane	10.0	5.00	2.50	ug/Kg	30-160	30	160	30	QSM	225/202	74-83-9
Solid	8260B	Carbon Disulfide	5.00	2.50	1.25	ug/Kg	45-160	45	160	30	QSM	225/202	75-15-0
Solid	8260B	Carbon Tetrachloride	5.00	2.50	1.25	ug/Kg	65-135	65	135	30	QSM	225/202	56-23-5
Solid	8260B	Chlorobenzene	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	108-90-7
Solid	8260B	Chloroethane	10.0	5.00	2.50	ug/Kg	40-155	40	155	30	QSM	225/202	75-00-3
Solid	8260B	Chloroform	5.00	2.50	1.25	ug/Kg	70-125	70	125	30	QSM	225/202	67-66-3
Solid	8260B	Chloromethane	10.0	5.00	2.50	ug/Kg	50-130	50	130	30	QSM	225/202	74-87-3
Solid	8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)	5.00	2.50	1.25	ug/Kg	65-125	65	125	30	QSM	225/202	156-59-2
Solid	8260B	cis-1,3-Dichloropropene	5.00	2.50	1.25	ug/Kg	70-125	70	125	30	QSM	225/202	10061-01-5
Solid	8260B	Cyclohexane	5.00	2.50	1.25	ug/Kg	65-140	65	140	30	Standard	225/202	110-82-7
Solid	8260B	Dibromochloromethane (Chlorodibromomethane)	5.00	2.50	1.25	ug/Kg	65-130	65	130	30	QSM	225/202	124-48-1
Solid	8260B	Dibromofluoromethane	30	2.5	1.25	ug/Kg	80-125	80	125	30	Surr	225/202	85-115
Solid	8260B	Dibromomethane	5.00	2.50	1.25	ug/Kg	75-130	75	130	30	QSM	225/202	74-95-3
Solid	8260B	Dichlorodifluoromethane (CFC-12)	10.0	5.00	2.50	ug/Kg	35-135	35	135	30	QSM	225/202	75-71-8
Solid	8260B	Ethylbenzene	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	100-41-4
Solid	8260B	Hexachlorobutadiene	5.00	2.50	1.25	ug/Kg	55-140	55	140	30	QSM	225/202	87-68-3

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Solid	8260B	Isopropylbenzene (Cumene)	5.00	2.50	1.25	ug/Kg	75-130	75	130	30	QSM	225/202	98-82-8
Solid	8260B	m,p-Xylene	10.0	5.00	2.50	ug/Kg	80-125	80	125	30	QSM	225/202	108-38-3/1
Solid	8260B	Methyl Acetate	10.0	5.00	2.50	ug/Kg	45-165	45	165	30	Standard	225/202	79-20-9
Solid	8260B	Methyl Tertiary Butyl Ether (MTBE)	5.00	2.50	1.25	ug/Kg	55-150	55	150	30	QSM	225/202	1634-04-4
Solid	8260B	Methylcyclohexane	5.00	2.50	1.25	ug/Kg	65-135	65	135	30	Standard	225/202	108-87-2
Solid	8260B	Methylene Chloride, or Dichloromethane	10.0	5.00	2.50	ug/Kg	55-140	55	140	30	QSM	225/202	75-09-2
Solid	8260B	Naphthalene	5.00	2.50	1.25	ug/Kg	40-125	40	125	30	QSM	225/202	91-20-3
Solid	8260B	n-Butylbenzene	5.00	2.50	1.25	ug/Kg	65-140	65	140	30	QSM	225/202	104-51-8
Solid	8260B	n-Propylbenzene	5.00	2.50	1.25	ug/Kg	65-135	65	135	30	QSM	225/202	103-65-1
Solid	8260B	o-Xylene	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	95-47-6
Solid	8260B	p-Isopropyltoluene	5.00	2.50	1.25	ug/Kg	75-130	75	130	30	QSM	225/202	99-87-6
Solid	8260B	sec-Butylbenzene	5.00	2.50	1.25	ug/Kg	65-130	65	130	30	QSM	225/202	135-98-8
Solid	8260B	Styrene	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	100-42-5
Solid	8260B	tert-Butylbenzene	5.00	2.50	1.25	ug/Kg	65-130	65	130	30	QSM	225/202	98-06-6
Solid	8260B	Tetrachloroethene (PCE; PERC)	5.00	2.50	1.25	ug/Kg	65-140	65	140	30	QSM	225/202	127-18-4
Solid	8260B	Toluene	5.00	2.50	1.25	ug/Kg	70-125	70	125	30	QSM	225/202	108-88-3
Solid	8260B	Toluene-d8	30	2.5	1.25	ug/Kg	85-115	85	115	30	Surr	225/202	85-120
Solid	8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)	5.00	2.50	1.25	ug/Kg	65-135	65	135	30	QSM	225/202	156-60-5
Solid	8260B	trans-1,3-Dichloropropene	5.00	2.50	1.25	ug/Kg	65-125	65	125	30	QSM	225/202	10061-02-6
Solid	8260B	Trichloroethene (TCE)	5.00	2.50	1.25	ug/Kg	75-125	75	125	30	QSM	225/202	79-01-6
Solid	8260B	Trichlorofluoromethane (CFC-11)	10.0	5.00	2.50	ug/Kg	25-185	25	185	30	QSM	225/202	75-69-4
Solid	8260B	Vinyl Chloride (VC)	5.00	2.50	1.25	ug/Kg	60-125	60	125	30	QSM	225/202	75-01-4
Solid	8260B	Xylenes (total)	15.0	7.50	3.75	ug/Kg	75-125	75	125	30	Standard	225/202	1330-20-7
Solid	8270C/D	1,1'-Biphenyl	333	167	83.3	ug/Kg	45-110	45	110	30	Standard	343/201	92-52-4
Solid	8270C/D	1,2,4,5-Tetrachlorobenzene	333	167	83.3	ug/Kg	50-150	50	150	30	Standard	343/201	95-94-3
Solid	8270C/D	1,2,4-Trichlorobenzene	333	167	83.3	ug/Kg	45-110	45	110	30	QSM	343/201	120-82-1
Solid	8270C/D	1,2-Dichlorobenzene (DCB)	333	167	83.3	ug/Kg	45-95	45	95	30	QSM	343/201	95-50-1
Solid	8270C/D	1,2-Diphenylhydrazine	333	167	83.3	ug/Kg	10-110	10	110	30	QSM	343/201	122-66-7
Solid	8270C/D	1,3-Dichlorobenzene (DCB)	333	167	83.3	ug/Kg	40-100	40	100	30	QSM	343/201	541-73-1
Solid	8270C/D	1,4-Dichlorobenzene (DCB)	333	167	83.3	ug/Kg	35-105	35	105	30	QSM	343/201	106-46-7

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Solid	8270C/D	1-Methylnaphthalene	333	167	83.3	ug/Kg	30-110	30	110	30	QSM	343/201	90-12-0
Solid	8270C/D	2,3,4,6-Tetrachlorophenol	333	167	83.3	ug/Kg	50-125	50	125	30	Standard	343/201	58-90-2
Solid	8270C/D	2,4,5-Trichlorophenol	333	167	83.3	ug/Kg	50-110	50	110	30	QSM	343/201	95-95-4
Solid	8270C/D	2,4,6-Trichlorophenol (TCP)	333	167	83.3	ug/Kg	45-110	45	110	30	QSM	343/201	88-06-2
Solid	8270C/D	2,4-Dichlorophenol (DCP)	333	167	83.3	ug/Kg	45-110	45	110	30	QSM	343/201	120-83-2
Solid	8270C/D	2,4-Dimethylphenol	1330	667	333	ug/Kg	30-105	30	105	30	QSM	343/201	105-67-9
Solid	8270C/D	2,4-Dinitrophenol	3330	1670	833	ug/Kg	15-130	15	130	30	QSM	343/201	51-28-5
Solid	8270C/D	2,4-Dinitrotoluene (DNT)	333	167	83.3	ug/Kg	50-115	50	115	30	QSM	343/201	121-14-2
Solid	8270C/D	2,6-Dinitrotoluene	333	167	83.3	ug/Kg	50-110	50	110	30	QSM	343/201	606-20-2
Solid	8270C/D	2-Fluorobiphenyl	333	167	83.3	ug/Kg	45-105	45	105		Surr	343/201	321-60-8
Solid	8270C/D	2-Chloronaphthalene	333	167	83.3	ug/Kg	45-105	45	105	30	QSM	343/201	91-58-7
Solid	8270C/D	2-Chlorophenol	333	167	83.3	ug/Kg	45-105	45	105	30	QSM	343/201	95-57-8
Solid	8270C/D low	2-Fluorobiphenyl	6.67	3.33	1.67	ug/Kg	14-129	14	129		Surr	343/201	321-60-8
Solid	8270C/D	2-Fluorophenol	667	333	167	ug/Kg	35-105	35	105		Surr	343/201	367-12-4
Solid	8270C/D	2-Methylnaphthalene	333	167	83.3	ug/Kg	40-110	40	110	30	QSM	343/201	91-57-6
Solid	8270C/D	2-Methylphenol (o-Cresol)	333	167	83.3	ug/Kg	40-105	40	105	30	QSM	343/201	95-48-7
Solid	8270C/D	2-Nitroaniline	1330	667	333	ug/Kg	45-120	45	120	30	QSM	343/201	88-74-4
Solid	8270C/D	2-Nitrophenol (ONP)	333	167	83.3	ug/Kg	40-110	40	110	30	QSM	343/201	88-75-5
Solid	8270C/D	3,3'-Dichlorobenzidine (DCB)	333	167	83.3	ug/Kg	19-130	19	130	30	QSM	343/201	91-94-1
Solid	8270C/D	3-Methylphenol/4-Methylphenol	333	167	83.3	ug/Kg	40-105	40	105	30	QSM	343/201	108-39-4/106
Solid	8270C/D	3-Nitroaniline	1330	667	333	ug/Kg	25-110	25	110	30	QSM	343/201	100-01-6
Solid	8270C/D	4,6-Dinitro-2-methylphenol (DNOC)	3330	1670	833	ug/Kg	30-135	30	135	30	QSM	343/201	534-52-1
Solid	8270C/D	4-Bromophenyl phenyl ether	333	167	83.3	ug/Kg	45-115	45	115	30	QSM	343/201	101-55-3
Solid	8270C/D	4-Chloro-3-methylphenol	333	167	83.3	ug/Kg	45-115	45	115	30	QSM	343/201	59-50-7
Solid	8270C/D	4-Chloroaniline	333	167	83.3	ug/Kg	10-95	10	95	30	QSM	343/201	106-47-8
Solid	8270C/D	4-Chlorophenyl phenyl ether	333	167	83.3	ug/Kg	45-110	45	110	30	QSM	343/201	7005-72-3
Solid	8270C/D	4-Nitroaniline (PNA)	1330	667	333	ug/Kg	35-115	35	115	30	QSM	343/201	100-01-6
Solid	8270C/D	4-Nitrophenol (PNP)	1330	667	333	ug/Kg	15-140	15	140	30	QSM	343/201	100-02-7
Solid	8270C/D	Acenaphthene	333	167	83.3	ug/Kg	45-110	45	110	30	QSM	343/201	83-32-9
Solid	8270C/D	Acenaphthylene	333	167	83.3	ug/Kg	45-105	45	105	30	QSM	343/201	208-96-8

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Solid	8270C/D	Acetophenone	333	167	83.3	ug/Kg	35-110	35	110	30	Standard	343/201	98-86-2
Solid	8270C/D	Anthracene	333	167	83.3	ug/Kg	55-105	55	105	30	QSM	343/201	120-12-7
Solid	8270C/D	Atrazine	333	167	83.3	ug/Kg	55-105	55	105	30	Standard	343/201	1912-24-9
Solid	8270C/D	Benzaldehyde	333	167	83.3	ug/Kg	10-160	10	160	30	Standard	343/201	100-52-7
Solid	8270C/D	Benzo(a)anthracene	333	167	83.3	ug/Kg	50-110	50	110	30	QSM	343/201	56-55-3
Solid	8270C/D	Benzo(a)pyrene	333	167	83.3	ug/Kg	50-110	50	110	30	QSM	343/201	50-32-8
Solid	8270C/D	Benzo(b)fluoranthene	333	167	83.3	ug/Kg	45-115	45	115	30	QSM	343/201	205-99-2
Solid	8270C/D	Benzo(g,h,i)perylene	333	167	83.3	ug/Kg	40-125	40	125	30	QSM	343/201	191-24-2
Solid	8270C/D	Benzo(k)fluoranthene	333	167	83.3	ug/Kg	45-125	45	125	30	QSM	343/201	207-08-9
Solid	8270C/D	Benzoic Acid	1330	667	333	ug/Kg	0-110	0	110	30	QSM	343/201	65-85-0
Solid	8270C/D	Benzyl alcohol	333	167	83.3	ug/Kg	20-125	20	125	30	QSM	343/201	100-51-6
Solid	8270C/D	bis(2-Chloroethoxy)methane	333	167	83.3	ug/Kg	45-110	45	110	30	QSM	343/201	111-91-1
Solid	8270C/D	bis(2-Chloroethyl)ether (BCEE)	333	167	83.3	ug/Kg	40-105	40	105	30	QSM	343/201	111-44-4
Solid	8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	333	167	83.3	ug/Kg	20-115	20	115	30	QSM	343/201	108-60-1
Solid	8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)	333	167	83.3	ug/Kg	45-125	45	125	30	QSM	343/201	117-81-7
Solid	8270C/D	Butyl benzyl phthalate (BBP)	333	167	83.3	ug/Kg	50-125	50	125	30	QSM	343/201	85-68-7
Solid	8270C/D	Caprolactam	333	167	83.3	ug/Kg	50-110	50	110	30	Standard	343/201	105-60-2
Solid	8270C/D	Carbazole	333	167	83.3	ug/Kg	45-115	45	115	30	QSM	343/201	86-74-8
Solid	8270C/D	Chrysene	333	167	83.3	ug/Kg	55-110	55	110	30	QSM	343/201	218-01-9
Solid	8270C/D	Dibenz(a,h)anthracene	333	167	83.3	ug/Kg	40-125	40	125	30	QSM	343/201	53-70-3
Solid	8270C/D	Dibenzofuran (DBF)	333	167	83.3	ug/Kg	50-105	50	105	30	QSM	343/201	132-64-9
Solid	8270C/D	Diethyl phthalate (DEP)	333	167	83.3	ug/Kg	50-115	50	115	30	QSM	343/201	84-66-2
Solid	8270C/D	Dimethyl phthalate (DMP)	333	167	83.3	ug/Kg	50-110	50	110	30	QSM	343/201	131-11-3
Solid	8270C/D	Di-n-butyl phthalate (DBP)	333	167	83.3	ug/Kg	55-110	55	110	30	QSM	343/201	84-74-2
Solid	8270C/D	Di-n-octyl phthalate (DNOP)	333	167	83.3	ug/Kg	40-130	40	130	30	QSM	343/201	117-84-0
Solid	8270C/D	Fluoranthene	333	167	83.3	ug/Kg	55-115	55	115	30	QSM	343/201	206-44-0
Solid	8270C/D	Fluorene	333	167	83.3	ug/Kg	50-110	50	110	30	QSM	343/201	86-73-7
Solid	8270C/D	Hexachlorobenzene (HCB)	333	167	83.3	ug/Kg	45-120	45	120	30	QSM	343/201	118-74-1
Solid	8270C/D	Hexachlorobutadiene (HCBD)	333	167	83.3	ug/Kg	30-110	30	110	30	QSM	343/201	87-68-3

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
Solid	8270C/D	Hexachlorocyclopentadiene (HCCPD)	333	167	83.3	ug/Kg	10-110	10	110	30	Standard	343/201	77-47-4
Solid	8270C/D	Hexachloroethane (HCE)	333	167	83.3	ug/Kg	35-110	35	110	30	QSM	343/201	67-72-1
Solid	8270C/D	Indeno(1,2,3-cd)pyrene	333	167	83.3	ug/Kg	40-120	40	120	30	QSM	343/201	193-39-5
Solid	8270C/D	Isophorone	333	167	83.3	ug/Kg	45-110	45	110	30	QSM	343/201	78-59-1
Solid	8270C/D	Naphthalene	333	167	83.3	ug/Kg	40-105	40	105	30	QSM	343/201	91-20-3
Solid	8270C/D	Nitrobenzene	333	167	83.3	ug/Kg	40-115	40	115	30	QSM	343/201	98-95-3
Solid	8260B	Bromofluorobenzene	30	2.5	1.25	ug/Kg	85-120	85	120	30	Surr	225/202	460-00-4
Solid	8270C/D	N-Nitrosodimethylamine	333	167	83.3	ug/Kg	20-115	20	115	30	QSM	343/201	86-30-6
Solid	8270C/D	N-Nitroso-di-n-propylamine (NDPA)	333	167	83.3	ug/Kg	40-115	40	115	30	QSM	343/201	621-64-7
Solid	8270C/D	N-nitrosodiphenylamine (NDPHA)	333	167	83.3	ug/Kg	50-115	50	115	30	QSM	343/201	86-30-6
Solid	8270C/D	Pentachlorophenol	1330	667	333	ug/Kg	25-120	25	120	30	QSM	343/201	87-86-5
Solid	8270C/D	Phenanthrene	333	167	83.3	ug/Kg	50-110	50	110	30	QSM	343/201	85-01-8
Solid	8270C/D	Phenol	333	167	83.3	ug/Kg	40-100	40	100	30	QSM	343/201	108-95-2
Solid	8270C/D	Nitrobenzene-d5	333	167	83.3	ug/Kg	35-100	35	100		Surr	343/201	4165-60-0
Solid	8270C/D	Pyrene	333	167	83.3	ug/Kg	45-125	45	125	30	QSM	343/201	129-00-0
Solid	8270C/D	Phenol-d6	667	333	167	ug/Kg	40-100	40	100		Surr	343/201	13127-88-3
Solid	8270C/D	Terphenyl-d14	333	167	83.3	ug/Kg	30-125	30	125		Surr	343/201	1718-51-0
Solid	8270C/D low	Terphenyl-d14	6.67	3.33	1.67	ug/Kg	14-129	14	129		Surr	343/201	1718-51-0
Solid	8270C/D low	1-Methylnaphthalene	6.67	3.33	1.67	ug/Kg	30-111	30	111	30	QSM	343/201	90-12-0
Solid	8270C/D low	2-Methylnaphthalene	6.67	3.33	1.67	ug/Kg	30-111	30	111	30	QSM	343/201	91-57-6
Solid	8270C/D low	Acenaphthene	6.67	3.33	1.67	ug/Kg	28-110	28	110	30	QSM	343/201	83-32-9
Solid	8270C/D low	Acenaphthylene	6.67	3.33	1.67	ug/Kg	23-126	23	126	30	QSM	343/201	208-96-8
Solid	8270C/D low	Anthracene	6.67	3.33	1.67	ug/Kg	28-136	28	136	30	QSM	343/201	120-12-7
Solid	8270C/D low	Benzo(a)anthracene	6.67	3.33	1.67	ug/Kg	31-146	31	146	30	QSM	343/201	56-55-3
Solid	8270C/D low	Benzo(a)pyrene	6.67	3.33	1.67	ug/Kg	28-128	28	128	30	QSM	343/201	50-32-8
Solid	8270C/D low	Benzo(b)fluoranthene	6.67	3.33	1.67	ug/Kg	30-139	30	139	30	QSM	343/201	205-99-2
Solid	8270C/D low	Benzo(g,h,i)perylene	6.67	3.33	1.67	ug/Kg	21-149	21	149	30	QSM	343/201	191-24-2
Solid	8270C/D	Benzo(k)fluoranthene	6.67	3.33	1.67	ug/Kg	42-129	42	129	30	QSM	343/201	207-08-9

S/W	Method	Analyte	MRL / LOQ	LOD	MDL / DL	Units	Limits	Low	High	RPD	Class	SOP	CAS
	low												
Solid	8270C/D low	Chrysene	6.67	3.33	1.67	ug/Kg	39-134	39	134	30	QSM	343/201	218-01-9
Solid	8270C/D low	Dibenz (a,h) anthracene	6.67	3.33	1.67	ug/Kg	30-138	30	138	30	QSM	343/201	53-70-3
Solid	8270C/D low	Fluoranthene	6.67	3.33	1.67	ug/Kg	30-142	30	142	30	QSM	343/201	206-44-0
Solid	8270C/D low	Fluorene	6.67	3.33	1.67	ug/Kg	27-116	27	116	30	QSM	343/201	86-73-7
Solid	8270C/D low	Indeno (1,2,3-cd) pyrene	6.67	3.33	1.67	ug/Kg	17-164	17	164	30	QSM	343/201	193-39-5
Solid	8270C/D low	Naphthalene	6.67	3.33	1.67	ug/Kg	29-106	29	106	30	QSM	343/201	91-20-3
Solid	8270C/D low	Phenanthrene	6.67	3.33	1.67	ug/Kg	32-127	32	127	30	QSM	343/201	85-01-8
Solid	8270C/D low	Pyrene	6.67	3.33	1.67	ug/Kg	28-130	28	130	30	QSM	343/201	129-00-0

Empirical Laboratories, LLC Control Limits .vs.
DoD QSM Control Limits for Solid and Liquid Analytes

Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in a Solid Matrix

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Aluminum	7429-90-5	Solid	6010B/C	80-120	97.8-111
Antimony	7440-36-0	Solid	6010B/C	80-120	87.3-117
Arsenic	7440-38-2	Solid	6010B/C	80-120	87.7-110
Barium	7440-39-3	Solid	6010B/C	80-120	87.7-120
Beryllium	7440-41-7	Solid	6010B/C	80-120	91.5-114
Cadmium	7440-43-9	Solid	6010B/C	80-120	100-112
Calcium	7440-70-2	Solid	6010B/C	80-120	98.7-116
Chromium, total	7440-47-3	Solid	6010B/C	80-120	94.3-118
Cobalt	7440-48-4	Solid	6010B/C	80-120	84.5-117
Copper	7440-50-8	Solid	6010B/C	80-120	76.2-138
Iron	7439-89-6	Solid	6010B/C	80-120	99.8-127
Lead	7439-92-1	Solid	6010B/C	80-120	86.3-118
Magnesium	7439-95-4	Solid	6010B/C	80-120	83-122
Manganese	7439-96-5	Solid	6010B/C	80-120	94.4-120
Nickel	7440-02-0	Solid	6010B/C	80-120	91.9-116
Potassium	7440-09-7	Solid	6010B/C	80-120	94.6-108
Selenium	7782-49-2	Solid	6010B/C	80-120	83.8-110
Silver	7440-22-4	Solid	6010B/C	80-120	93.7-106
Sodium	7440-23-5	Solid	6010B/C	80-120	86.7-119
Thallium	7440-28-0	Solid	6010B/C	80-120	83.3-116
Vanadium	7440-62-2	Solid	6010B/C	80-120	94.8-115
Zinc	7440-66-6	Solid	6010B/C	80-120	87.4-117
Mercury	7439-97-6	Solid	7471A/B	80-120	85.1-116
4,4'-DDD	72-54-8	Solid	8081A/B	30-135	96.9-170
4,4'-DDE	72-55-9	Solid	8081A/B	70-125	92.9-170
4,4'-DDT	50-29-3	Solid	8081A/B	45-140	77.8-192
Aldrin	309-00-2	Solid	8081A/B	45-140	91.7-137
alpha-BHC (alpha-HCH)	319-84-6	Solid	8081A/B	60-125	92.7-140
alpha-Chlordane	5103-71-9	Solid	8081A/B	65-120	87.2-143
beta-BHC (beta-HCH)	319-85-7	Solid	8081A/B	60-125	99.1-137
delta-BHC (delta-HCH)	319-86-8	Solid	8081A/B	55-130	77-150
Dieldrin	60-57-1	Solid	8081A/B	65-125	84.7-147
Endosulfan I	959-98-8	Solid	8081A/B	15-135	85.7-146
Endosulfan II	33213-65-9	Solid	8081A/B	35-140	92.7-144
Endosulfan sulfate	1031-07-8	Solid	8081A/B	60-135	91.4-152
Endrin	72-20-8	Solid	8081A/B	60-135	73.1-145
Endrin aldehyde	7421-93-4	Solid	8081A/B	35-145	87.3-128
Endrin ketone	53494-70-5	Solid	8081A/B	65-135	97.4-154
gamma-BHC (Lindane; gamma-HCH)	58-89-9	Solid	8081A/B	60-125	95.3-143
gamma-Chlordane	5103-74-2	Solid	8081A/B	65-125	83.9-150

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Heptachlor	76-44-8	Solid	8081A/B	50-140	64.9-170
Heptachlor epoxide	1024-57-3	Solid	8081A/B	65-130	91.3-144
Methoxychlor	72-43-5	Solid	8081A/B	55-145	92-168
Toxaphene	8001-35-2	Solid	8081A/B	50-150	40.5-124
Aroclor-1016	12674-11-2	Solid	8082A	40-140	80.8-164
Aroclor-1221	11104-28-2	Solid	8082A	*40-140 (if spiked)*	NA
Aroclor-1232	11141-16-5	Solid	8082A	*40-140 (if spiked)*	NA
Aroclor-1242	53469-21-9	Solid	8082A	*40-140 (if spiked)*	NA
Aroclor-1248	12672-29-6	Solid	8082A	*40-140 (if spiked)*	NA
Aroclor-1254	11097-69-1	Solid	8082A	*40-140 (if spiked)*	NA
Aroclor-1260	11096-82-5	Solid	8082A	*60-130*	68.9-163
1,1,1,2-Tetrachloroethane	630-20-6	Solid	8260B	75-125	70.7-129
1,1,1-Trichloroethane (1,1,1-TCA)	71-55-6	Solid	8260B	70-135	70.3-133
1,1,2,2-Tetrachloroethane	79-34-5	Solid	8260B	55-130	59.5-120
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	76-13-1	Solid	8260B	20-185	63.7-120
1,1,2-Trichloroethane	79-00-5	Solid	8260B	60-125	64.9-128
1,1-Dichloroethane (1,1-DCA)	79-34-3	Solid	8260B	75-125	71.3-119
1,1-Dichloroethene (1,1-DCE)	75-35-4	Solid	8260B	65-135	69.6-118
1,1-Dichloropropene	563-58-6	Solid	8260B	70-135	72.8-121
1,2,3-Trichlorobenzene	87-61-6	Solid	8260B	60-130	63.2-131
1,2,3-Trichloropropane	96-18-4	Solid	8260B	65-130	61-8-130
1,2,4-Trichlorobenzene	120-82-1	Solid	8260B	65-130	61-6-134
1,2,4-Trimethylbenzene	95-63-6	Solid	8260B	65-135	65-127
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	Solid	8260B	40-135	54.6-137
1,2-Dibromoethane (EDB)	106-93-4	Solid	8260B	70-125	61.9-132
1,2-Dichlorobenzene (12DCB)	95-50-1	Solid	8260B	75-120	66.3-121
1,2-Dichloroethane (EDC)	107-06-2	Solid	8260B	70-135	59.9-135
1,2-Dichloroethene (Total)	540-59-0	Solid	8260B	65-135	59.9-135
1,2-Dichloropropane	78-87-5	Solid	8260B	70-120	72.4-118
1,3,5-Trimethylbenzene	108-67-8	Solid	8260B	65-135	66.4-129
1,3-Dichlorobenzene (13DCB)	541-73-1	Solid	8260B	70-125	64.9-120
1,3-Dichloropropane	142-28-9	Solid	8260B	75-125	66.1-122
1,4-Dichlorobenzene (14DCB)	106-46-7	Solid	8260B	70-125	64.8-120
2,2-Dichloropropane	594-20-7	Solid	8260B	65-135	65.6-130
2-Butanone (Methyl ethyl ketone; MEK)	78-93-3	Solid	8260B	30-160	38.6-152
2-Chlorotoluene	95-49-8	Solid	8260B	70-130	66.5-116
2-Hexanone (Methyl butyl ketone; MBK)	591-78-6	Solid	8260B	45-145	44.4-152
4-Chlorotoluene	106-34-4	Solid	8260B	75-125	66.7-116
4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	108-10-1	Solid	8260B	45-145	60-145
Acetone	67-64-1	Solid	8260B	20-160	1.26-174

Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in a Water Matrix

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Aluminum	7429-90-5	Water	6010B/C	80-120	88.6-111
Antimony	7440-36-0	Water	6010B/C	80-120	84.8-122
Arsenic	7440-38-2	Water	6010B/C	80-120	92.6-106
Barium	7440-39-3	Water	6010B/C	80-120	90.1-112
Beryllium	7440-41-7	Water	6010B/C	80-120	87.7-110
Cadmium	7440-43-9	Water	6010B/C	80-120	98.4-110
Calcium	7440-70-2	Water	6010B/C	80-120	88.7-118
Chromium, total	7440-47-3	Water	6010B/C	80-120	92-108
Cobalt	7440-48-4	Water	6010B/C	80-120	81.8-116
Copper	7440-50-8	Water	6010B/C	80-120	80.9-124
Iron	7439-89-6	Water	6010B/C	80-120	86.4-127
Lead	7439-92-1	Water	6010B/C	80-120	86.6-115
Magnesium	7439-95-4	Water	6010B/C	80-120	80.7-115
Manganese	7439-96-5	Water	6010B/C	80-120	91.2-113
Nickel	7440-02-0	Water	6010B/C	80-120	92.6-109
Potassium	7440-09-7	Water	6010B/C	80-120	85.5-105
Selenium	7782-49-2	Water	6010B/C	80-120	89.7-104
Silver	7440-22-4	Water	6010B/C	80-120	85.4-107
Sodium	7440-23-5	Water	6010B/C	80-120	88.7-111
Thallium	7440-28-0	Water	6010B/C	80-120	78.6-125
Vanadium	7440-62-2	Water	6010B/C	80-120	85.6-109
Zinc	7440-66-6	Water	6010B/C	80-120	91.3-108
Mercury	7439-97-6	Water	7470A	80-120	83.1-115
4,4'-DDD	72-54-8	Water	8081A/B	25-150	27.5-175
4,4'-DDE	72-55-9	Water	8081A/B	35-140	27.5-171
4,4'-DDT	50-29-3	Water	8081A/B	45-140	28.7-172
Aldrin	309-00-2	Water	8081A/B	25-140	31-8-133
alpha-BHC (alpha-HCH)	319-84-6	Water	8081A/B	60-130	41.5-152
alpha-Chlordane	5103-71-9	Water	8081A/B	65-125	36.3-135
beta-BHC (beta-HCH)	319-85-7	Water	8081A/B	65-125	35.1-152
delta-BHC (delta-HCH)	319-86-8	Water	8081A/B	45-135	31.5-167
Dieldrin	60-57-1	Water	8081A/B	60-130	40.7-154
Endosulfan I	959-98-8	Water	8081A/B	50-110	40.4-150
Endosulfan II	33213-65-9	Water	8081A/B	30-130	39.7-155
Endosulfan sulfate	1031-07-8	Water	8081A/B	55-155	38.8-159
Endrin	72-20-8	Water	8081A/B	55-135	32.1-159
Endrin aldehyde	7421-93-4	Water	8081A/B	55-135	26.8-155
Endrin ketone	53494-70-5	Water	8081A/B	75-125	37.9-163
gamma-BHC (Lindane; gamma-HCH)	58-89-9	Water	8081A/B	25-135	41.2-155
gamma-Chlordane	5103-74-2	Water	8081A/B	60-125	29.4-152

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Heptachlor	76-44-8	Water	8081A/B	40-130	33.8-150
Heptachlor epoxide	1024-57-3	Water	8081A/B	60-130	39.9-151
Methoxychlor	72-43-5	Water	8081A/B	55-150	19.7-182
Toxaphene	8001-35-2	Water	8081A/B	50-150	-14.7-156
Aroclor-1016	12674-11-2	Water	8082A	25-145	38.6-160
Aroclor-1221	11104-28-2	Water	8082A	*30-145 (if spiked)*	NA
Aroclor-1232	11141-16-5	Water	8082A	*30-145 (if spiked)*	NA
Aroclor-1242	53469-21-9	Water	8082A	*30-145 (if spiked)*	NA
Aroclor-1248	12672-29-6	Water	8082A	*30-145 (if spiked)*	NA
Aroclor-1254	11097-69-1	Water	8082A	*30-145 (if spiked)*	NA
Aroclor-1260	11096-82-5	Water	8082A	30-145	25.9-148
1,1,1,2-Tetrachloroethane	630-20-6	Water	8260B	80-130	80.2-124
1,1,1-Trichloroethane (1,1,1-TCA)	71-55-6	Water	8260B	65-130	79.7-129
1,1,2,2-Tetrachloroethane	79-34-5	Water	8260B	65-130	78.9-128
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	76-13-1	Water	8260B	60-130	68.1-125
1,1,2-Trichloroethane	79-00-5	Water	8260B	75-125	85.9-119
1,1-Dichloroethane (1,1-DCA)	79-34-3	Water	8260B	70-135	84.5-118
1,1-Dichloroethene (1,1-DCE)	75-35-4	Water	8260B	70-130	71.9-117
1,1-Dichloropropene	563-58-6	Water	8260B	75-130	87.9-116
1,2,3-Trichlorobenzene	87-61-6	Water	8260B	55-140	60.2-137
1,2,3-Trichloropropane	96-18-4	Water	8260B	75-125	81.9-119
1,2,4-Trichlorobenzene	120-82-1	Water	8260B	65-135	68.2-130
1,2,4-Trimethylbenzene	95-63-6	Water	8260B	75-130	84.4-121
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	Water	8260B	50-130	76.2-126
1,2-Dibromoethane (EDB)	106-93-4	Water	8260B	80-120	84.2-117
1,2-Dichlorobenzene (12DCB)	95-50-1	Water	8260B	70-120	83.7-116
1,2-Dichloroethane (EDC)	107-06-2	Water	8260B	70-130	72.3-128
1,2-Dichloroethene (Total)	540-59-0	Water	8260B	60-140	86.8-117
1,2-Dichloropropane	78-87-5	Water	8260B	75-125	85.6-118
1,3,5-Trimethylbenzene	108-67-8	Water	8260B	75-130	86.6-123
1,3-Dichlorobenzene (13DCB)	541-73-1	Water	8260B	75-125	83.6-114
1,3-Dichloropropane	142-28-9	Water	8260B	75-125	85.2-116
1,4-Dichlorobenzene (14DCB)	106-46-7	Water	8260B	75-125	83.5-115
2,2-Dichloropropane	594-20-7	Water	8260B	70-135	67.4-134
2-Butanone (Methyl ethyl ketone; MEK)	78-93-3	Water	8260B	30-150	68.5-134
2-Chlorotoluene	95-49-8	Water	8260B	75-125	79.3-121
2-Hexanone (Methyl butyl ketone; MBK)	591-78-6	Water	8260B	55-130	72.9-135
4-Chlorotoluene	106-34-4	Water	8260B	75-130	79.9-120
4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	108-10-1	Water	8260B	60-135	71.4-143
Acetone	67-64-1	Water	8260B	40-140	39.8-146

Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in a Water Matrix

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Benzene	71-43-2	Water	8260B	80-120	87.9-117
Bromobenzene	108-86-1	Water	8260B	75-125	83.4-120
Bromochloromethane	74-97-5	Water	8260B	65-130	84.4-121
Bromodichloromethane (Dibromochloromethane)	75-27-4	Water	8260B	75-120	79.3-120
Bromoform	75-25-2	Water	8260B	70-130	58-133
Bromomethane (methyl bromide)	74-83-9	Water	8260B	30-145	28.1-149
Carbon Disulfide	75-15-0	Water	8260B	35-160	57.8-123
Carbon Tetrachloride	56-23-5	Water	8260B	65-140	76.6-134
Chlorobenzene	108-90-7	Water	8260B	80-120	80.7-114
Chloroethane	75-00-3	Water	8260B	60-135	72.2-142
Chloroform	67-66-3	Water	8260B	65-135	77.7-118
Chloromethane (methyl chloride)	74-87-3	Water	8260B	40-125	40.5-128
cis-1,2-Dichloroethene (cis-1,2-DCE)	156-59-2	Water	8260B	70-125	85.7-117
cis-1,3-Dichloropropene	10061-01-5	Water	8260B	70-130	92-123
Cyclohexane	110-82-7	Water	8260B	60-130	71.5-119
Dibromochloromethane (Chlorodibromomethane)	124-48-1	Water	8260B	60-135	78.3-123
Dibromomethane	74-95-3	Water	8260B	75-125	84.1-117
Dichlorodifluoromethane (CFC-12)	75-71-8	Water	8260B	30-155	42.9-158
Ethylbenzene	100-41-4	Water	8260B	75-125	86.7-115
Hexachlorobutadiene (HCBD)	87-68-3	Water	8260B	50-140	60.1-135
Isopropylbenzene (Cumene)	98-82-8	Water	8260B	75-125	80.3-110
m,p-Xylene	108-38-3/106-42-3	Water	8260B	75-130	84.7-117
Methyl Acetate	79-20-9	Water	8260B	55-150	62-134
Methyl Tertiary Butyl Ether (MTBE)	1634-04-4	Water	8260B	65-125	85.2-120
Methylcyclohexane	108-87-2	Water	8260B	60-125	83.1-116
Methylene Chloride, or Dichloromethane	75-09-2	Water	8260B	55-140	72.2-116
o-Xylene	95-47-6	Water	8260B	80-120	83.1-115
Styrene	100-42-5	Water	8260B	65-135	81.8-119
Tetrachloroethene (PCE; PERC)	127-18-4	Water	8260B	45-150	79.6-119
Toluene	108-88-3	Water	8260B	75-120	84.6-115
trans-1,2-Dichloroethene (trans-1,2-DCE)	156-60-5	Water	8260B	60-140	86-119
trans-1,3-Dichloropropene	10061-02-6	Water	8260B	55-140	74.7-110
Trichloroethene (TCE)	79-01-6	Water	8260B	70-125	85.6-119
Trichlorofluoromethane (CFC-11)	75-69-4	Water	8260B	60-145	72.7-137
Vinyl Chloride (VC)	75-01-4	Water	8260B	50-145	78.7-147
Xylenes (total)	1330-20-7	Water	8260B	75-130	84.3-116
1,1'-Biphenyl	92-52-4	Water	8270C/D	50-110	52.7-123
1,2,4,5-Tetrachlorobenzene	95-94-3	Water	8270C/D	50-125	50.6-123
1,2,4-Trichlorobenzene	120-82-1	Water	8270C/D	35-105	34.2-93.1
1,2-Dichlorobenzene (12DCB)	95-50-1	Water	8270C/D	35-100	35.6-92

Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in a Water Matrix

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
1,3-Dichlorobenzene (13DCB)	541-73-1	Water	8270C/D	30-100	31.1-88.6
1,4-Dichlorobenzene (14DCB)	106-46-7	Water	8270C/D	30-100	32.9-90
2,3,4,6-Tetrachlorophenol	58-90-2	Water	8270C/D	50-125	38.8-129
2,4,5-Trichlorophenol	95-95-4	Water	8270C/D	50-110	48.8-129
2,4,6-Trichlorophenol (TCP)	88-06-2	Water	8270C/D	50-115	47.2-123
2,4-Dichlorophenol (DCP)	120-83-2	Water	8270C/D	40-110	39.9-115
2,4-Dimethylphenol	105-67-9	Water	8270C/D	30-110	37.5-115
2,4-Dinitrophenol	51-28-5	Water	8270C/D	15-140	10.4-159
2,4-Dinitrotoluene (DNT)	121-14-2	Water	8270C/D	50-120	63.3-127
2,6-Dichlorophenol (DCP)	87-65-0	Water	8270C/D	40-110	43.4-127
2,6-Dinitrotoluene	606-20-2	Water	8270C/D	50-115	60-120
2-Chloronaphthalene	91-58-7	Water	8270C/D	50-105	48.1-107
2-Chlorophenol	95-57-8	Water	8270C/D	35-105	35.3-98.3
2-Methylnaphthalene	91-57-6	Water	8270C/D	45-105	42.8-109
2-Methylphenol (o-Cresol)	95-48-7	Water	8270C/D	40-110	25.6-85.1
2-Nitroaniline	88-74-4	Water	8270C/D	50-115	50.7-138
2-Nitrophenol (ONP)	88-75-5	Water	8270C/D	40-115	46-123
3,3'-Dichlorobenzidine (DCB)	91-94-1	Water	8270C/D	20-110	47.8-126
3-Methylphenol/4-Methylphenol	108-39-4/106	Water	8270C/D	30-110	22.8-77.5
3-Nitroaniline	100-01-6	Water	8270C/D	20-125	40.5-111
4,6-Dinitro-2-methylphenol (DNOC)	534-52-1	Water	8270C/D	40-130	46.8-142
4-Bromophenyl phenyl ether	101-55-3	Water	8270C/D	50-115	61.3-124
4-Chloro-3-methylphenol	59-50-7	Water	8270C/D	45-110	40.1-115
4-Chloroaniline	106-47-8	Water	8270C/D	15-110	36.4-106
4-Chlorophenyl phenyl ether	7005-72-3	Water	8270C/D	50-110	55.5-125
4-Nitroaniline (PNA)	100-01-6	Water	8270C/D	35-120	53.4-129
4-Nitrophenol (PNP)	100-02-7	Water	8270C/D	0-125	6.75-47.4
Acenaphthene	83-32-9	Water	8270C/D	45-110	50.4-114
Acenaphthylene	208-96-8	Water	8270C/D	50-105	51.3-113
Acetophenone	98-86-2	Water	8270C/D	50-110	51.2-123
Anthracene	120-12-7	Water	8270C/D	55-110	59-119
Atrazine	1912-24-9	Water	8270C/D	70-115	59.7-131
Benzaldehyde	100-52-7	Water	8270C/D	10-180	47.5-121
Benzo(a)anthracene	56-55-3	Water	8270C/D	55-110	63.6-121
Benzo(a)pyrene	50-32-8	Water	8270C/D	55-110	59.3-121
Benzo(b)fluoranthene	205-99-2	Water	8270C/D	45-120	56.2-137
Benzo(g,h,i)perylene	191-24-2	Water	8270C/D	40-125	58.9-124
Benzo(k)fluoranthene	207-08-9	Water	8270C/D	45-125	53.6-129
bis(2-Chloroethoxy)methane	111-91-1	Water	8270C/D	45-105	51.1-123
bis(2-Chloroethyl)ether (BCEE)	111-44-4	Water	8270C/D	35-110	49.3-112

Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in a Water Matrix

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	108-60-1	Water	8270C/D	25-130	39.1-118
bis(2-Ethylhexyl)phthalate (BEHP)	117-81-7	Water	8270C/D	40-125	62.9-139
Butyl benzyl phthalate (BBP)	85-68-7	Water	8270C/D	45-115	63.4-144
Caprolactam	105-60-2	Water	8270C/D	20-110	3.42-29.8
Carbazole	86-74-8	Water	8270C/D	50-115	57.2-121
Chrysene	218-01-9	Water	8270C/D	55-110	63.6-126
Dibenz(a,h)anthracene	53-70-3	Water	8270C/D	40-125	61.1-125
Dibenzofuran (DBF)	132-64-9	Water	8270C/D	55-105	54.6-119
Diethyl phthalate (DEP)	84-66-2	Water	8270C/D	40-120	62.3-128
Dimethyl phthalate (DMP)	131-11-3	Water	8270C/D	25-125	55.1-131
Di-n-butyl phthalate (DBP)	84-74-2	Water	8270C/D	55-115	63.8-129
Di-n-octyl phthalate (DNOP)	117-84-0	Water	8270C/D	35-135	54.4-150
Fluoranthene	206-44-0	Water	8270C/D	55-115	59.8-121
Fluorene	86-73-7	Water	8270C/D	50-110	59.3-121
Hexachlorobenzene (HCB)	118-74-1	Water	8270C/D	50-110	57.1-123
Hexachlorobutadiene (HCBD)	87-68-3	Water	8270C/D	25-105	24.6-104
Hexachlorocyclopentadiene (HCCPD)	77-47-4	Water	8270C/D	10-110	3.81-132
Hexachloroethane (HCE)	67-72-1	Water	8270C/D	30-95	22.9-87.8
Indeno(1,2,3-cd)pyrene	193-39-5	Water	8270C/D	45-125	60.4-125
Isophorone	78-59-1	Water	8270C/D	50-110	46.1-109
Naphthalene	91-20-3	Water	8270C/D	40-100	45.4-104
Nitrobenzene	98-95-3	Water	8270C/D	30-110	46.1-114
N-Nitrosodimethylamine	86-30-6	Water	8270C/D	25-110	18-50.2
N-Nitroso-di-n-propylamine (NDPA)	621-64-7	Water	8270C/D	35-130	53.4-120
N-nitrosodiphenylamine (NDPHA)	86-30-6	Water	8270C/D	50-110	40.2-105
Pentachlorophenol	87-86-5	Water	8270C/D	40-115	43.5-136
Phenanthrene	85-01-8	Water	8270C/D	50-115	55.9-126
Phenol	108-95-2	Water	8270C/D	0-115	9.4-34.8
Pyrene	129-00-0	Water	8270C/D	50-130	54.1-131
2-Methylnaphthalene	91-57-6	Water	8270C/D low	36-121	32-117
Acenaphthene	83-32-9	Water	8270C/D low	41-132	51.3-106
Acenaphthylene	208-96-8	Water	8270C/D low	43-140	51.8-111
Anthracene	120-12-7	Water	8270C/D low	50-139	49.9-99.8
Benzo(a)anthracene	56-55-3	Water	8270C/D low	58-141	50.9-96.3
Benzo(a)pyrene	50-32-8	Water	8270C/D low	31-142	47.9-98.5
Benzo(b)fluoranthene	205-99-2	Water	8270C/D low	42-156	54.2-111
Benzo(g,h,i)perylene	191-24-2	Water	8270C/D low	12-171	50.6-109
Benzo(k)fluoranthene	207-08-9	Water	8270C/D low	49-165	58.4-104
Chrysene	218-01-9	Water	8270C/D low	51-155	54.7-98.1
Dibenz (a,h) anthracene	53-70-3	Water	8270C/D low	28-153	46-105

Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in a Water Matrix

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Fluoranthene	206-44-0	Water	8270C/D low	47-158	61.6-104
Fluorene	86-73-7	Water	8270C/D low	40-140	53.4-107
Indeno (1,2,3-cd) pyrene	193-39-5	Water	8270C/D low	20-167	58.9-105
Naphthalene	91-20-3	Water	8270C/D low	39-125	46-115
Phenanthrene	85-01-8	Water	8270C/D low	46-144	61.3-111
Pyrene	129-00-0	Water	8270C/D low	39-158	60-103

Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in a Solid Matrix

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Benzene	71-43-2	Solid	8260B	75-125	74.9-121
Bromobenzene	108-86-1	Solid	8260B	65-120	68.6-120
Bromochloromethane	74-97-5	Solid	8260B	70-125	70.3-133
Bromodichloromethane (Dibromochloromethane)	75-27-4	Solid	8260B	70-130	69.3-121
Bromoform	75-25-2	Solid	8260B	55-135	60.7-140
Bromomethane (methyl bromide)	74-83-9	Solid	8260B	30-160	53.8-158
Carbon Disulfide	75-15-0	Solid	8260B	45-160	51-114
Carbon Tetrachloride	56-23-5	Solid	8260B	65-135	70.5-137
Chlorobenzene	108-90-7	Solid	8260B	75-125	63-127
Chloroethane	75-00-3	Solid	8260B	40-155	75.1-129
Chloroform	67-66-3	Solid	8260B	70-125	70.6-122
Chloromethane (methyl chloride)	74-87-3	Solid	8260B	50-130	53.3-125
cis-1,2-Dichloroethene (cis-1,2-DCE)	156-59-2	Solid	8260B	65-125	72.7-124
cis-1,3-Dichloropropene	10061-01-5	Solid	8260B	70-125	74.4-127
Cyclohexane	110-82-7	Solid	8260B	65-140	59.5-116
Dibromochloromethane (Chlorodibromomethane)	124-48-1	Solid	8260B	65-130	68.4-128
Dibromomethane	74-95-3	Solid	8260B	75-130	70.3-124
Dichlorodifluoromethane (CFC-12)	75-71-8	Solid	8260B	35-135	42.1-141
Ethylbenzene	100-41-4	Solid	8260B	75-125	68.3-125
Hexachlorobutadiene (HCBD)	87-68-3	Solid	8260B	55-140	63.7-124
Isopropylbenzene (Cumene)	98-82-8	Solid	8260B	75-130	61.9-123
m,p-Xylene	108-38-3/106-42-3	Solid	8260B	80-125	68.6-126
Methyl Acetate	79-20-9	Solid	8260B	45-165	59-132
Methyl Tertiary Butyl Ether (MTBE)	1634-04-4	Solid	8260B	55-150	69.6-125
Methylcyclohexane	108-87-2	Solid	8260B	65-135	70.5-125
Methylene Chloride, or Dichloromethane	75-09-2	Solid	8260B	55-140	38.7-153
o-Xylene	95-47-6	Solid	8260B	75-125	65.6-125
Styrene	100-42-5	Solid	8260B	75-125	62.2-132
Tetrachloroethene (PCE; PERC)	127-18-4	Solid	8260B	65-140	58.2-142
Toluene	108-88-3	Solid	8260B	70-125	64.5-125
trans-1,2-Dichloroethene (trans-1,2-DCE)	156-60-5	Solid	8260B	65-135	74.7-121
trans-1,3-Dichloropropene	10061-02-6	Solid	8260B	65-125	62.4-110
Trichloroethene (TCE)	79-01-6	Solid	8260B	75-125	74.2-122
Trichlorofluoromethane (CFC-11)	75-69-4	Solid	8260B	25-185	69.6-139
Vinyl Chloride (VC)	75-01-4	Solid	8260B	60-125	59.4-156
Xylenes (total)	1330-20-7	Solid	8260B	75-125	67.7-126
1,1'-Biphenyl	92-52-4	Solid	8270C/D	45-110	56.7-124
1,2,4,5-Tetrachlorobenzene	95-94-3	Solid	8270C/D	50-150	60.4-124
1,2,4-Trichlorobenzene	120-82-1	Solid	8270C/D	45-110	57.7-108
1,2-Dichlorobenzene (12DCB)	95-50-1	Solid	8270C/D	45-95	58.7-108

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
1,3-Dichlorobenzene (13DCB)	541-73-1	Solid	8270C/D	40-100	59.2-105
1,4-Dichlorobenzene (14DCB)	106-46-7	Solid	8270C/D	35-105	58.8-105
2,3,4,6-Tetrachlorophenol	58-90-2	Solid	8270C/D	50-125	52.9-125
2,4,5-Trichlorophenol	95-95-4	Solid	8270C/D	50-110	67.9-123
2,4,6-Trichlorophenol (TCP)	88-06-2	Solid	8270C/D	45-110	68.5-118
2,4-Dichlorophenol (DCP)	120-83-2	Solid	8270C/D	45-110	65.8-111
2,4-Dimethylphenol	105-67-9	Solid	8270C/D	30-105	63.5-111
2,4-Dinitrophenol	51-28-5	Solid	8270C/D	15-130	62.5-145
2,4-Dinitrotoluene (DNT)	121-14-2	Solid	8270C/D	50-115	63.2-132
2,6-Dichlorophenol (DCP)	87-65-0	Solid	8270C/D	45-110	68.8-123
2,6-Dinitrotoluene	606-20-2	Solid	8270C/D	50-110	62.4-120
2-Chloronaphthalene	91-58-7	Solid	8270C/D	45-105	60.7-112
2-Chlorophenol	95-57-8	Solid	8270C/D	45-105	59.4-110
2-Methylnaphthalene	91-57-6	Solid	8270C/D	40-110	61.8-117
2-Methylphenol (o-Cresol)	95-48-7	Solid	8270C/D	40-105	54.9-111
2-Nitroaniline	88-74-4	Solid	8270C/D	45-120	63.7-124
2-Nitrophenol (ONP)	88-75-5	Solid	8270C/D	40-110	65.7-120
3,3'-Dichlorobenzidine (DCB)	91-94-1	Solid	8270C/D	19-130	49.1-121
3-Methylphenol/4-Methylphenol	108-39-4/106	Solid	8270C/D	40-105	55.2-117
3-Nitroaniline	100-01-6	Solid	8270C/D	25-110	38.3-116
4,6-Dinitro-2-methylphenol (DNOC)	534-52-1	Solid	8270C/D	30-135	70-132
4-Bromophenyl phenyl ether	101-55-3	Solid	8270C/D	45-115	65.4-126
4-Chloro-3-methylphenol	59-50-7	Solid	8270C/D	45-115	66.9-116
4-Chloroaniline	106-47-8	Solid	8270C/D	10-95	40.6-109
4-Chlorophenyl phenyl ether	7005-72-3	Solid	8270C/D	45-110	64.5-119
4-Nitroaniline (PNA)	100-01-6	Solid	8270C/D	35-115	66.1-126
4-Nitrophenol (PNP)	100-02-7	Solid	8270C/D	15-140	62.6-122
Acenaphthene	83-32-9	Solid	8270C/D	45-110	62.4-116
Acenaphthylene	208-96-8	Solid	8270C/D	45-105	64.8-112
Acetophenone	98-86-2	Solid	8270C/D	35-110	57.7-118
Anthracene	120-12-7	Solid	8270C/D	55-105	67-118
Atrazine	1912-24-9	Solid	8270C/D	55-105	49-143
Benzaldehyde	100-52-7	Solid	8270C/D	10-160	33.9-122
Benzo(a)anthracene	56-55-3	Solid	8270C/D	50-110	67.6-123
Benzo(a)pyrene	50-32-8	Solid	8270C/D	50-110	62.4-121
Benzo(b)fluoranthene	205-99-2	Solid	8270C/D	45-115	64.5-131
Benzo(g,h,i)perylene	191-24-2	Solid	8270C/D	40-125	60.6-130
Benzo(k)fluoranthene	207-08-9	Solid	8270C/D	45-125	61.1-121
bis(2-Chloroethoxy)methane	111-91-1	Solid	8270C/D	45-110	65.8-114
bis(2-Chloroethyl)ether (BCEE)	111-44-4	Solid	8270C/D	40-105	64.6-108

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	108-60-1	Solid	8270C/D	20-115	41.9-122
bis(2-Ethylhexyl)phthalate (BEHP)	117-81-7	Solid	8270C/D	45-125	60.3-156
Butyl benzyl phthalate (BBP)	85-68-7	Solid	8270C/D	50-125	64-154
Caprolactam	105-60-2	Solid	8270C/D	50-110	61.3-143
Carbazole	86-74-8	Solid	8270C/D	45-115	68.4-115
Chrysene	218-01-9	Solid	8270C/D	55-110	67.7-124
Dibenz(a,h)anthracene	53-70-3	Solid	8270C/D	40-125	65.3-128
Dibenzofuran (DBF)	132-64-9	Solid	8270C/D	50-105	64.7-121
Diethyl phthalate (DEP)	84-66-2	Solid	8270C/D	50-115	61.2-126
Dimethyl phthalate (DMP)	131-11-3	Solid	8270C/D	50-110	68.9-124
Di-n-butyl phthalate (DBP)	84-74-2	Solid	8270C/D	55-110	69.4-128
Di-n-octyl phthalate (DNOP)	117-84-0	Solid	8270C/D	40-130	51.1-154
Fluoranthene	206-44-0	Solid	8270C/D	55-115	65.8-117
Fluorene	86-73-7	Solid	8270C/D	50-110	63.8-117
Hexachlorobenzene (HCB)	118-74-1	Solid	8270C/D	45-120	61.6-123
Hexachlorobutadiene (HCBD)	87-68-3	Solid	8270C/D	30-110	60.9-129
Hexachlorocyclopentadiene (HCCPD)	77-47-4	Solid	8270C/D	10-110	40.9-135
Hexachloroethane (HCE)	67-72-1	Solid	8270C/D	35-110	53.8-107
Indeno(1,2,3-cd)pyrene	193-39-5	Solid	8270C/D	40-120	63.9-129
Isophorone	78-59-1	Solid	8270C/D	45-110	52.3-108
Naphthalene	91-20-3	Solid	8270C/D	40-105	60.2-116
Nitrobenzene	98-95-3	Solid	8270C/D	40-115	58.5-104
N-Nitrosodimethylamine	86-30-6	Solid	8270C/D	20-115	43.2-121
N-Nitroso-di-n-propylamine (NDPA)	621-64-7	Solid	8270C/D	40-115	60.4-116
N-nitrosodiphenylamine (NDPHA)	86-30-6	Solid	8270C/D	50-115	48.3-100
Pentachlorophenol	87-86-5	Solid	8270C/D	25-120	50-157
Phenanthrene	85-01-8	Solid	8270C/D	50-110	65.8-123
Phenol	108-95-2	Solid	8270C/D	40-100	55-110
Pyrene	129-00-0	Solid	8270C/D	45-125	57.3-135
2-Methylnaphthalene	91-57-6	Solid	8270C/D low	30-111	45.6-115
Acenaphthene	83-32-9	Solid	8270C/D low	28-110	62.3-104
Acenaphthylene	208-96-8	Solid	8270C/D low	23-126	60.8-107
Anthracene	120-12-7	Solid	8270C/D low	28-136	65.1-102
Benzo(a)anthracene	56-55-3	Solid	8270C/D low	31-146	35.2-130
Benzo(a)pyrene	50-32-8	Solid	8270C/D low	28-128	60-106
Benzo(b)fluoranthene	205-99-2	Solid	8270C/D low	30-139	59-115
Benzo(g,h,i)perylene	191-24-2	Solid	8270C/D low	21-149	57-115
Benzo(k)fluoranthene	207-08-9	Solid	8270C/D low	42-129	62.5-112
Chrysene	218-01-9	Solid	8270C/D low	39-134	42.2-127
Dibenz (a,h) anthracene	53-70-3	Solid	8270C/D low	30-138	53.9-116

Empirical Laboratories, LLC Control Limits .vs. DoD QSM Control Limits for Analytes in a Solid Matrix

Analyte	CAS	Matrix	Method	DOD QSM Limits	Empirical 3 Standard Deviations Statictical Limits
Fluoranthene	206-44-0	Solid	8270C/D low	30-142	62.7-111
Fluorene	86-73-7	Solid	8270C/D low	27-116	66.1-105
Indeno (1,2,3-cd) pyrene	193-39-5	Solid	8270C/D low	17-164	56.2-115
Naphthalene	91-20-3	Solid	8270C/D low	29-106	59.1-103
Phenanthrene	85-01-8	Solid	8270C/D low	32-127	67.8-107
Pyrene	129-00-0	Solid	8270C/D low	28-130	62.5-112