Volume 2

Final Remedial Investigation/Feasibility Study Workplan & Associated Documents

Crab Orchard National Wildlife Refuge, Marion, IL

Additional and Uncharacterized Sites

SAMPLING & ANALYSIS PLAN

APRIL, 2006

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FIELD SAMPLING PLAN

VOLUME 2

ADDITIONAL AND UNCHARACTERIZED SITES OPERABLE UNIT
CRAB ORCHARD NWR
MARION, ILLINOIS WILLIAMSON COUNTY
(Final)

APRIL 2006

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LIST OF ACRONYMS/ABBREVIATIONS

ASTM	American Society for Testing Materials
ATV	All-Terrain Vehicle
AOC	Administrative Order on Consent
AUS OU	Additional and Uncharacterized Refuges Operable Unit
C°	Celsius
COC	Chain-of-Custody
CONWR	Crab Orchard National Wildlife Refuge
CRA	Conestoga-Rovers & Associates
DOI	Department of the Interior
DOT	Department of Transportation
DPT	Direct Push Technology
EDD	Electronic Data Deliverable
ENTRIX	ENTRIX Inc.
FFA	Federal Facilities Agreement
FS	Feasibility Study
FSP	Field Sampling Plan
FWS	Fish and Wildlife Service
GD-OTS	General Dynamics Ordnance and Tactical System, Inc.
GPS	Global Positioning System
HSA	Hollow Stem Auger
HSP	Health and Safety Plan
ID	Inner Diameter
IDW	Investigation-Derived Waste
IEPA	Illinois Environmental Protection Agency
IOP	Illinois Ordnance Plant
LFP	Low-Flow Procedures
mL	Milliliter
MS	Matrix Spike
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAVD	North American Vertical Datum
NewFields	NewFields Companies, L.L.C.
NPL	National Priorities List
NTU	Nephelometric Turbidity Units
OD	Outer Diameter
ORP	Oxidation/Reduction Potential
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbons
PA/SI	Preliminary Assessment/Site Inspection
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
PRPs	Potentially Responsible Parties
PSI	Pounds Per Square Inch

LIST OF ACRONYMS/ABBREVIATIONS

PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
Refuge	Crab Orchard National Wildlife Refuge
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SIM	Selective Ion Monitoring
SOP	Standard Operating Procedure
SPL	Southern Petroleum Labs
STL	Severn Trent Laboratories
TAL	Target Analyte List
TCL	Target Compound List
TDS	Total Dissolved Solids
TNT	2,4,6-trinitrotoluene
TOC	Total Organic Carbon
TSS	Total Suspended Solids
USCS	Unified Soil Classification System
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WP	Work Plan
YSI	Yellow Springs Incorporated

1.0 INTRODUCTION

This Field Sampling Plan (FSP) has been prepared to provide the field procedures and sampling protocols for the Remedial Investigation/Feasibility Study (RI/FS) field activities to be conducted at the Additional and Uncharacterized Sites Operable Unit (AUS OU) at the Crab Orchard National Wildlife Refuge ("CONWR" or "Refuge") in Marion, Illinois.

The FSP has been developed in support of the RI/FS Work Plan (Work Plan). In addition to Work Plan and FSP, other documents have been prepared to assist in the goal of successfully completing the RI/FS and are incorporated by reference including:

- Quality Assurance Project Plan (QAPP); and
- Health and Safety Plan (HSP).

1.1 OBJECTIVES

The RI/FS is focused on 32 sites. The purpose of the RI is to assess AUS OU conditions and to obtain any data necessary to adequately characterize the AUS OU for the purposes of evaluating remedial alternatives. The primary objective of the FS is to ensure that appropriate remedial alternatives are developed, evaluated, and presented to the decision-makers for remedy selection.

1.2 OVERVIEW

The CONWR is administered by the United States Department of Interior (DOI) - Fish and Wildlife Service (FWS) and is located approximately 5 miles west of the City of Marion in Williamson, Jackson, and Union Counties in southern Illinois. The Refuge consists of approximately 43,500 acres of forests, grassland areas, cropland, wetlands, and industrial areas. A portion of the area now occupied by the CONWR was operated as the Illinois Ordnance Plant (IOP) during World War II. The IOP occupied approximately 22,000 acres and contained 534 buildings and various utilities, including steam generation; water, sewage and wastewater treatment facilities; and a railroad line. The IOP operations consisted of seven load lines, three of which were 2,4,6-trinitrotoluene (TNT) melt-pour operations for shells, bombs, and mines; the other four lines were for the production of boosters, detonators, primers, and fuses for shells, bombs, and mines. There were 14 separate areas of IOP activity that were identified by the functions conducted in the area during World War II. Later the various IOP areas were given number (Areas 1 through 14.). Recently these sites were further subdivided. Figure 1.1 shows the locations of the CONWR AUS OU sites.

The items included in the FSP are:

- mobilization and demobilization;
- obtaining and providing for access to the various sample, boring, and well locations;
- AUS OU security and safety during drilling and sampling operations;
- utility and subsurface structure clearance;
- unexploded ordnance (UXO) avoidance;
- installation and sampling of borings (hand auger, direct push technology (DPT), and drill rig);
- installation of overburden monitoring wells, piezometers and/or of temporary wells;
- collection of groundwater screening samples and groundwater sampling;
- inspection, development, sampling, and gauging of existing and new monitoring wells;
- gauging of groundwater monitoring wells and piezometers;
- hydrologic testing (single well response test);
- surface water and sediment sampling;
- surveying of locations of soil borings, piezometers, groundwater monitor wells, and surface/sediment sample points;
- removal, transport, testing, and proper disposal of investigation-derived wastes (IDW) generated during drilling and sampling;
- concrete/pavement coring and repair;
- health and safety;
- obtaining necessary approvals for the work; and
- laboratory testing of soil, water, and sediment samples.

1.3 STANDARD OPERATING PROCEDURES

The FSP incorporates a number of field Site-Specific Standard Operating Procedures (SOPs) for various investigative tasks to be performed during the RI/FS.

The field SOPs are provided in Appendix A and include the following:

SOP 1	Decontamination of Drill Rigs and Equipment
SOP 2	Decontamination of Soil and Groundwater Field Equipment
SOP 3	Borehole Installation and Sampling (Overburden)
SOP 4	Surface Soil Sampling
SOP 5	Monitoring Well, Piezometer, and Temporary Well Construction and Development
SOP 6	Groundwater and Fluid Level Monitoring
SOP 7	Groundwater Sampling
SOP 8	Single-Well Response Tests
SOP 9	Sample Management and Field QA/QC
SOP 0025-002	Standard Operating Procedure for Collecting Sediment Samples
SOP 0025-003	Standard Operating Procedure for Collecting Surface Water Samples
SOP 0025-004	Standard Operating Procedure for Decontaminating Sediment Sampling Equipment
SOP 0025-006	Standard Operating Procedure for the Collection of Specific Conductance (SC) Data in Freshwater Ecosystems
SOP 0025-007	Standard Operating Procedure for the Collection of Redox Potential (ORP) in Freshwater Ecosystems
SOP 0025-008	Standard Operating Procedure for the Collection of pH Data from Freshwater Ecosystems

2.0 GENERAL FIELD PROTOCOLS

2.1 OVERVIEW

General protocols that are applicable to a number of field activities to be completed during the RI/FS are summarized in this section. AUS-0A4W is proposed as the primary operations area during the RI/FS where the field office trailer, central decontamination pad, and primary equipment and supplies storage would be set up. This location is preferred because it is relatively level, gravel paved, has access to Highway 148 and areas both north and south of Crab Orchard Lake; has improved gravel drives, concrete pavement, and security fencing; and local availability of utilities such as electric, telephone, sewer, and water. This location has been discussed with and approved by both FWS and General Dynamics Ordnance and Tactical Systems Inc. (GD-OTS).

2.2 EQUIPMENT DECONTAMINATION PROTOCOLS

2.2.1 DRILLING RIGS AND EQUIPMENT

The central decontamination pad will be constructed in area AUS-0A4W to accommodate cleaning of the drilling rigs and equipment upon arrival to the Refuge, prior to performing drilling activities, and when a drilling rig leaves the Refuge upon completion of the work. Additionally, the drilling rigs will be cleaned at the central decontamination pad after completion of work in a site, prior to proceeding to the next site. The central decontamination facility will have the appropriate equipment to thoroughly clean the drilling rigs and drilling equipment as described herein and to facilitate capture of cleaning fluids and sediments for proper management. The central decontamination will be constructed in a manner and will have sufficient capacity and pumping capability to prevent any overflow of fluids during decontamination activities. Figure 2.1 depicts the general detail of the central equipment decontamination pad.

A number of temporary equipment decontamination facilities will be constructed and operated at the various sites to clean downhole drilling equipment. Use of these temporary facilities will eliminate the need to travel potentially large distances from remote areas of the Refuge to the central decontamination facility to clean drilling equipment, tools, and sampling equipment. The temporary decontamination facilities will likely consist of a large metal trough, steel drum, or a kiddy-pool, which will be used to contain fluids during decontamination.

The temporary decontamination facilities will have the appropriate equipment to thoroughly clean the drilling equipment, drilling tools, and sampling equipment and facilitate capture of cleaning fluids and sediments for proper management. In the event that a rig and or HAS need to be decontaminated at a specific AUS a temporary decontamination pad of sufficient size will be constructed. This temporary decontamination pad would be constructed of 6-mil polyethylene sheeting covered with plywood and have a berm sufficient to capture all of the decontamination fluids. Figure 2.2 of the FSP depicts the general detail of this type of a temporary equipment decontamination pad. Although not shown on Figure 2.2 plywood side shields will be used to contain over spray.

Details regarding the procedures to be used to decontaminate drilling rigs and equipment are provided in SOP 1 (Decontamination of Drill Rigs and Equipment) found in Appendix A.

2.2.2 SOIL AND GROUNDWATER SAMPLING EQUIPMENT

This section details the decontamination of sampling equipment used for collecting soil and groundwater samples. Decontamination procedures for sampling equipment to be used to collect sediment samples are provided in SOP 0025-004.

Non-disposable soil and groundwater sampling equipment (trowels, spoons, hand shovels, scoops, pumps, etc.) will be decontaminated prior to field use and after each sample is collected to prevent cross-contamination between samples. Duplicate samples will be collected concurrently with original samples; therefore, sampling equipment will not be decontaminated before collection of the duplicate samples. Detailed protocols for decontamination of field equipment used to collect soil and groundwater samples are provided in SOP 2(Decontamination of Soil and Groundwater Sampling Equipment) found in Appendix A.

2.2.3 SURFACE WATER AND SEDIMENT SAMPLING EQUIPMENT

During surface water and sediment sampling, the sampling team's personal protective equipment (PPE) generally remains free of mud and debris with the exception of wading boots and waders. Additionally, as described below, there are no decontamination protocols associated with surface water sampling. However, sediment sampling equipment will require decontamination as discussed herein.

2.2.3.1 SURFACE WATER SAMPLING EQUIPMENT

Surface water will be collected using a simple technique of submersing the sampling vessel into the water body to be sampled. The sampling teams will receive analytically-clean sample containers directly from the analytical laboratory. These sample containers will be filled with surface water at various locations predetermined by the sampling team. Once filled, the sampling containers will be shipped to the laboratory using the protocols outlined in Section 5.3. Because there are no additional sampling materials beyond the sample containers used to collect the surface water, no decontamination procedures are required associated with sampling surface water for this project.

Surface water samples submitted for dissolved metals analysis will be filtered in the field. A peristaltic pump, disposable Teflon tubing, and a disposable 0.45 μ filter will be utilized in the field. Therefore, no decontamination of this equipment will be required. However, sampling equipment that does not directly contact the sample will be kept clean to minimize the potential of affecting sample results. Refer to SOP 0025-003 for detailed sampling procedure.

2.2.3.2 SEDIMENT SAMPLING EQUIPMENT

The field teams will follow all applicable health and safety protocols while decontaminating equipment as well as follow the Standard Operating Procedure for Decontaminating Sediment Sampling Equipment SOP 0025-004 (Appendix A).

Sediment sampling requires a number of different items to complete collection activities. The items include but are not limited to:

- fiberglass boat or "bass-buddy";
- plastic or stainless steel core barrel;
- core extruder;
- plastic or stainless steel knife;
- stainless steel bowl;
- stainless steel spoon;
- powder-free nitrile and shoulder-length gloves;

- core barrel caps;
- stainless steel extension bar;
- plastic garden sprayers; and
- stainless-steel "tee" handle.

As outlined in the Standard Operating Procedure for Collecting Sediment Samples (SOP 0025-002 (Appendix A)), when submitting a sediment sample for inorganic analysis (i.e., heavy metals, cyanide, mercury, etc.), sampling materials that come into contact with the sample will be constructed of plastic only to avoid cross-contamination. Items such as the plastic core barrel and plastic knife will be discarded once used and, therefore, no decontamination is necessary. However, when submitting samples for organic analysis, only materials constructed of stainless steel will be used. Stainless steel items will require decontamination prior to being used for sampling sediment.

Sampling crews will establish a temporary decontamination area away from areas that may cause cross-contamination to equipment. Areas that will be avoided include but are not limited to highway/major traffic areas, railroad right of ways, and areas where sampling materials could come into contact with airborne contaminants from industrial emissions (stacks, vent pipes, etc.). The sampling crews will decon and wrap in plastic several sets of sediment sampling materials so that multiple locations can be sampled.

2.2.3.3 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Sediments can be collected either by wading or by utilizing a boat if the sediments are too deep to sample. If sediments are sampled by wading, wader boots and waders come into contact with sediments in the area of the sampling location. Field teams will decontaminate wader boots and waders to prevent cross-contamination between sampling locations. To decontaminate wader boots and waders, sampling personnel stand in the first tub filled with potable water and a non-phosphate detergent. With the assistance from other sampling personnel who have donned shoulder-length gloves and safety glasses, the boots and waders of each sampling crew member will be thoroughly decontaminated using a brush and the detergent/water mixture. A garden sprayer can also be utilized to remove material and rinse equipment. Once the boots and waders have been decontaminated, sampling personnel will be rinsed with distilled water by the sprayer. Sampling personnel do not enter the second tub for rinsing. This rinse water will be collected in the first tub. Once the rinsing is conducted, sampling personnel may step out of the first tub. The decontamination water will be drummed.

2.3 ACCESS TO WORK LOCATIONS

2.3.1 OVERVIEW

Prior to proceeding with the fieldwork at any investigation locations, the following activities will be completed:

- surface UXO avoidance activities to clear and mark access pathways prior to entry into the potential UXO areas identified below;
- utility clearances;
- potential disturbance to the area assessed, identified to, and cleared by the FWS; and
- removal of vegetation (trees, shrubs, etc.).

Removal of trees larger than 3 inches in diameter will require a permit from the FWS. (Note: Mowing activities to clear vegetation must be cleared by the FWS.)

This section describes activities to be conducted to obtain access to investigative locations.

2.3.2 UNEXPLODED ORDNANCE (UXO) AVOIDANCE

2.3.2.1 OVERVIEW

Due to the past history of operations, the potential for UXO exists in some areas of the Refuge. Based on the available information about the Refuge contained in the Preliminary Assessment/Site Inspection (PA/SI) (FWS, 2003), discussions with FWS personnel, and discussions with the UXO subcontractor (EOD Technology, Inc.), it has been determined to conduct the RI investigations under the assumption that UXOs were not present in formal production or storage areas, namely that the IOP and its successive contractors followed basic explosives safety protocols and regulations. Based on experience at other Army Ammunition Plants that would have been operated in a similar fashion, explosives and ordnance production followed very stringent requirements related to explosives accountability.

Accordingly, the primary concern in production areas is explosives residue on the ground and in sumps, but loaded ordnance are normally not an issue. Sump sampling is not being conducted as part of the investigation, as such, is not currently an issue. The explosives residues that would be encountered both on the surface and in the subsurface soils will not be in pure form due to degradation over time (as chemically unstable compounds and mixture with soil/water). In addition, explosives generally do not pose an explosive hazard unless confined or in the presence of an adequate initiating force. In the absence of either/both, the explosives residues might, at most, deflagrate (burn) rather than detonate. Accordingly, the risk associated with encountering the explosives residues in this project would be comparable to encountering a combustible solid.

Loaded ordnance or significant quantities of explosives in one place are most likely to be associated with burning grounds, detonation areas, holding/storage ponds, transfer ditches, test fire ranges, and burial areas. Based on a review of the available operational information about the Refuge the following sites will require UXO avoidance activities prior to and during field investigative activities.

AUS-0A02B

- Ordnance waste outside the south fence line.
- Suspected burn pad located to the southwest of the IOP Booster Load Line.

AUS-0A06

- Buried explosives adjacent to Igloos HE-7-11 and HE-7-12.

AUS-0A10

- Former burial of ignitable/explosive waste in pits (pits were closed, but status of waste is not known).

AUS-A11N and AUS-A11S

- Former burning trenches at 11N.
- Ponds and ditches at 11S.

AUS-0A12

- Propellant and explosives storage ponds.
- Burn ground.

AUS-0A13

- Nitroglycerine contamination near the loading dock.

AUS-0061

- Explosives testing/disposal.
- Trenches potentially containing explosives.

AUS-0062

- Any proposed locations within the landfill footprint.

AUS-0066

- Ordnance waste and explosives waste.

AUS-0067

- Unknown use.

AUS-0069

- Scrap metal and mine bodies found alongside the hayfield.

AUS-106A

- Drums in disposal area east of Building 11.

2.3.2.2 SURFACE UXO AVOIDANCE ACTIVITIES

Prior to conducting any intrusive investigations in the areas identified above, surface UXO avoidance activities will be conducted to clear pathways to sampling locations. A qualified contractor, such as EOD Technologies, Inc. of Knoxville, Tennessee, with properly trained and experienced personnel will perform surface and subsurface UXO avoidance.

As the name implies, UXO avoidance activities will be completed during Phase I investigation activities. If a subsurface anomaly is identified by the magnetometer during UXO avoidance activities, the potential UXO location will be conspicuously marked by the UXO avoidance contractor with posts and flagging tape and its location will be communicated to all AUS OU personnel during the daily health and safety briefings. Sampling locations will be moved as appropriate to avoid potential UXO. Figure 2.3 illustrates the portions of the Refuge where UXO avoidance activities will be performed. All flagged locations will be further investigated during the Phase II investigation. The specifics of the UXO investigation and associated field activities will be detailed in the Phase II Work Plan.

In the areas identified as requiring UXO avoidance, the initial AUS OU UXO pathway avoidance activities will begin prior to the mobilization of drilling equipment and project investigative teams. Prior to commencing any investigative activities at the identified AUS OU, surface UXO avoidance will be performed to establish routes to the investigative locations. The routes to the sampling locations will be a minimum of 10 feet or, if vehicular access is required, twice the width of the widest vehicle to be used at the investigative location. The UXO avoidance team will conspicuously and frequently mark the approach pathways using fluorescent green stakes and fluorescent green flagging tape to ensure that personnel will not stray from the cleared pathways. A sufficiently large area will be cleared around the investigative locations to allow the drilling equipment to maneuver on and off the drilling location. At a minimum, this area will be a 25-foot radius around the boring location but may be larger depending on specific needs. The cleared investigative borehole locations will also be clearly marked by UXO personnel using fluorescent orange painted stakes and fluorescent orange flagging tape. If the UXO contractor identifies an unexplained anomaly, the approach pathway will be diverted around the anomaly or the investigative location will be moved away from the anomaly.

The initial access activities will begin by providing the UXO subcontractor with maps of the AUS OU along with instructions as to where to initiate UXO avoidance activities and what sequence to perform these activities. CRA and/or ENTRIX personnel will accompany the UXO avoidance teams and provide assistance with identification of the best pathways of approach to the individual soil, monitoring wells, and sediment and surface water sampling locations. However, CRA and ENTRIX personnel will not enter any area prior to the completion of UXO surface avoidance activity.

Once the pathways to the investigation locations are selected, the UXO contractor will then conduct UXO avoidance activities to the locations, as well as to the area to be investigated (i.e., soil borings, monitoring well locations, etc.). Surface UXO avoidance activities are expected to be non-intrusive. However, communication with the FWS will occur prior to initiation of surficial UXO avoidance activities, and the FWS will be advised of the progress of these activities so that any potential ecological issues can be identified as quickly as possible. UXO avoidance activities will precede sequentially in a given geographical group of AUS OU locations until UXO avoidance in the entire area is completed.

The pathways and investigative locations cleared by the UXO subcontractor will be clearly marked in the field with fluorescent green stakes and fluorescent green flagging tape to ensure that personnel will not stray from the cleared pathways. The Field

Supervisor will ensure that efforts will be undertaken to preserve these markings to minimize the need for surface avoidance activities to be repeated. If field personnel find the access markings to be damaged or missing, this situation will be immediately communicated to the Field Supervisor or the Assistant Field Supervisor and the area will be cleared again by the UXO contractor prior to conducting any work.

The UXO contractor (including the UXO Technician and the Safety Observer) will document all surface UXO avoidance activities. The UXO contractor will notify the CRA/ENTRIX Field Supervisor and/or the CRA Assistant Field Supervisor when areas have been cleared for access and sampling. The CRA/ENTRIX Field Supervisor will communicate the status of UXO avoidance activities to the field personnel. **Under no circumstances are field sampling teams authorized to initiate investigative activities or enter a suspect UXO area without direct authorization of the CRA Field Supervisor/HSO or the Assistant Field Supervisor during Phase I investigations.** The status of UXO avoidance activities will be discussed during daily health and safety briefings. Documentation of UXO avoidance activities will be kept in the field office files.

2.3.2.3 SUBSURFACE UXO AVOIDANCE ACTIVITIES

In the identified potential UXO areas where intrusive investigative activities are to be performed, downhole UXO avoidance activities will be conducted. For subsurface soil borings (depths greater than 4 feet below grade) and monitoring well installations, downhole UXO avoidance activities will be required. Each 2-foot sampling interval will be cleared during borehole advancement beginning at 4 feet below ground surface. The UXO personnel will clear each subsequent 2-foot sampling interval to a minimum depth of 10 feet using a downhole magnetometer. Upon reaching a depth of 10 feet below ground surface, downhole UXO avoidance activities may be terminated if undisturbed native soil is present. Otherwise, downhole UXO avoidance activities will continue until undisturbed native soil is encountered.

Subsurface soil borings for soil sample collection will be advanced using DPT technology. The DPT rig will also be used to conduct the initial 10-foot avoidance activities at a number of the monitoring well locations. Downhole UXO avoidance will be conducted inside the DPT borehole following removal of the DPT sampling probe. In the event that the borehole wall collapsed, the borehole could be re-advanced to the target depth and a 2-inch diameter PVC pipe installed to facilitate downhole UXO avoidance activities.

Identified areas of potential subsurface UXO material will be further investigated during the Phase II investigation. The specifics of the UXO investigation and associated field activities will be detailed in the Phase II Work Plan.

2.3.3 UTILITY CLEARANCE

Utility clearances will be performed at all areas where intrusive activities will be performed. Where needed, utility clearances will begin following completion of UXO avoidance activities. Public utility clearances will be conducted through Illinois’ one-call system (JULIE) and by directly contacting any local utilities not participating in the one-call service system. The activities associated with clearing utilities at intrusive locations will require input from Refuge (Refuge Maintenance Supervisor) and GD-OTS personnel. Additionally, a private locating service may be subcontracted to clear private utilities, particularly in the industrial areas.

2.3.3.1 PROCEDURE

The subcontractor performing the intrusive activity will conduct the utility clearance through Illinois' one-call system (JULIE) and by contacting any local utilities not participating in the one-call service system. CRA will conduct utility clearance through Illinois' one-call system and by contacting any utilities not participating in the one-call system for areas of the Refuge where a subcontractor will not be involved in the subsurface activities. Joint utility meetings will be performed as necessary to clear remote areas of the Refuge.

2.3.3.2 DOCUMENTATION

The subcontractor performing the intrusive activity will provide CRA with the JULIE utility clearance reference number. CRA will complete the Property Access/Utility Clearance Data Sheet (QSF-019) prior to commencing intrusive activities (Appendix B).

2.4 MANAGEMENT OF INVESTIGATIVE WASTE

2.4.1 GENERAL REFUSE

Given the fact that the investigation will be conducted in a publicly accessible wildlife refuge, the utmost care will be given to the management of general refuse. General refuse, including office trailer waste, plastic sheeting, buckets, paper bags, etc., will be removed from the Refuge. General refuse will be collected in plastic bags and disposed of in the trash receptacle at the office trailer. Arrangements for a steel trash receptacle and refuse pick up during investigative work will be made with a local refuse disposal contractor. The general refuse container will be staged near the field office trailer.

2.4.2 INVESTIGATION-DERIVED WASTE (IDW)

Various IDW, including PPE, decontamination fluids and sediments, soil cuttings, drilling fluids, and purged groundwater will be generated during the investigation. Decontamination fluids and sediment, drill cuttings, and drilling fluids will be temporarily transferred to Department of Transportation (DOT) approved 55-gallon steel drums and staged at the temporary decontamination facilities or investigative locations. Temporarily drummed sediment, drill cuttings, and drilling fluids will be moved to the IDW staging area upon completion of the investigative work in the area but at a frequency of no less than once per week. AUS 0A2R has been selected as the central IDW staging area during the RI/FS. The central IDW staging area in AUS 0A2R will be inspected weekly (during periods of active fieldwork).

General IDW containment requirements include the following.

- Drill spoils and drilling fluids will be temporarily containerized at each location in DOT-approved steel 55-gallon drums. The drums will be clearly and conspicuously labeled on the lid and side with label and marker with a description of the contents (e.g., drill cuttings from borehole SB-1), AUS location, and the date of generation. The amount of IDW to be generated at DPT boreholes is expected to be minimal (a few pounds per location). Therefore, drill cuttings from separate DPT boreholes will be consolidated into a single drum.
- Soil cutting will be placed into drums and temporarily staged in a designated area of the AUS (where work is currently being performed). These drums of soil cuttings will regularly be transported from the AUS staging area to the main support area located at AUS 0A2R. At the main staging area the soil cuttings will be transferred into lined rolloff storage container. The tarp covering the rolloff storage containers

will be covered nightly and during precipitation events. The emptied drums will be reused. A log of the source of the IDW put into each rolloff box will be maintained.

- Purged groundwater from well development and sampling activities will temporarily be staged in tanks or drums at the point of generation. The purged groundwater will then be transported to the central IDW staging area where it will be staged in bulk in larger plastic or steel tanks pending characterization and disposal. Groundwater purged from monitoring wells where the contaminant concentrations are known or suspected to be elevated may be segregated from groundwater purged from other locations. The intent is to minimize the amount of purged groundwater that may potentially require management as characteristically hazardous waste.
- Decontamination solids and sediments will be collected and transferred into the lined roll-off boxes noted above.
- Decontamination fluids will be collected in plastic tanks or 55-gallon drums and delivered to a storage tank that will be staged in bulk in plastic tanks located at the central IDW staging area. The storage tanks will be clearly and conspicuously labeled with paint marker with a description of the contents. In any event, decontamination fluids will be staged separately from other IDW fluids (i.e., purged groundwater and drilling fluids).

IDW will be handled in a manner to minimize to potential of spills. As precautionary measure secondary containment items consisting of a polyethylene spill berm will be constructed around each of the storage tanks used to hold liquid IDW, and roll-off boxes will be lined with polyethylene sheeting and then covered when not being used/filled. Additionally, the IDW tanks and roll-off boxes will be inspected regularly during field activities.

IDW will be managed in a manner consistent with the protocols and procedures detailed in the document "Guide to Management of Investigation-Derived Wastes" (OSWER Publication 9345.3-03FS dated January 1992). As stated in the IDW guidance document: "*Site managers should not assume that a waste considered to pose a potential risk at a CERCLA site is a listed or characteristic RCRA hazardous waste. Until there is positive evidence (records, test results, other knowledge of waste properties) that the IDW is a RCRA hazardous waste, site managers should manage it in a protective manner (but not necessarily in accordance with Subtitle C requirements).*" As there are no specific records indicating that the materials released were regulated RCRA hazardous wastes or were derived from a regulated process at the time of the release, none of the IDW generated at the AUS OU sites is expected to be listed hazardous waste.

Routinely, the separate IDW streams will be characterized for proper disposal. Representative samples of each waste stream will be collected and sent to an environmental laboratory for waste characterization analyses. Following the results of waste characterization activities, as appropriate based on characterization data and waste medium, IDW will be disposed of at a permitted Subtitle D facility with Illinois special waste approval, a Subtitle C disposal facility, or a publicly owned treatment works (POTW). GD-OTS will ensure that IDW is transported only to facilities that are in compliance with their permit. IDW will be removed from the Site within 90 days of completion of field activities associated with the Phase I investigation.

Any hazardous waste will be manifested for disposal by GD-OTS using an appropriate generator identification number. GD-OTS will obtain a generator identification number for the disposal of the IDW (subject to approval/issuance by the Illinois EPA) or include it under its existing generation identification number.

3.0 GENERAL INVESTIGATIVE PROTOCOLS

3.1 OVERVIEW

Prior to mobilizing to an investigative area, the specific sampling and monitoring well locations will be marked in the field with stakes and orange flags or flagging tape by the surveyor and confirmed by the AUS OU access team (personnel conducting the initial sample locating) and the CRA/ENTRIX Field Supervisor or CRA Assistant Field Supervisor. Photographs of the AUS sampling locations will be taken prior to commencing sampling activities to document conditions prior to sampling. Monitoring well locations will be finalized following discussions with FWS and Federal Facilities Agreement (FFA) personnel.

3.2 SOIL BORINGS

Specific details regarding the number, sampling location, rationale, locations, and sampling details for the RI soil sampling program are provided in Section 5.0 of the RI/FS Work Plan. A small all-terrain vehicle (ATV) DPT rig will be the preferred equipment to advance soils borings. This equipment will maximize mobility and minimize the amount of vegetation clearing and removal in more remote areas of the Refuge.

Specific details regarding the installation of soil borings and boreholes are provided in SOP 3 Borehole Installation and Sampling) found in Appendix A.

3.2.1 DIRECT PUSH TECHNOLOGY

Soil samples will be collected and piezometers/temporary wells installed using DPT such as a Geoprobe® rig. To the extent possible, small and highly mobile DPT drill rigs (i.e., small track-mounted ATV rigs) are preferred to expedite sample collection activities, maximize ability to access remote locations, minimize disruption to the local environment and habitat, for ease of subsurface UXO clearance activities, and to minimize the volume of IDW generated during the investigation. Rotary drilling rigs equipped with hollow stem augers (HSA) may be used to collect soil samples if the subsurface formation or obstructions prevent the use of a DPT drill rig and/or for convenience/rig availability purposes, especially in developed areas of the Refuge.

In areas where UXO avoidance is necessary, personnel and equipment will stay on the pathways marked as described in Section 2.3.2 of this FSP. If the cleared pathways are not evident, personnel will avoid the area until appropriate markings are replaced. Downhole UXO avoidance will also be required in these areas. Downhole UXO avoidance will be performed as described in Section 2.3.2.3. UXO avoidance activities will be discussed during daily health and safety briefings.

3.2.2 ROTARY DRILLING RIGS

Subsurface soil samples collected using a rotary drilling rig will be obtained using a 2-foot long split-spoon sampler constructed of a stainless steel-lined barrel or, where soil samples will be collected for geotechnical analysis, Shelby tubes. Due to the difficulty associated with maneuvering the larger rotary drilling rigs back and forth over a borehole, in areas where monitoring wells are to be installed in UXO avoidance areas (see Section 2.3.2.1), downhole UXO avoidance and soil sampling in the vadose zone will be completed first using a DPT rig wherever possible. Surface and downhole UXO avoidance will be performed consistent with Sections 2.3.2.2 and 2.3.2.3 of this FSP and vadose zone soil samples for stratigraphic description and laboratory analysis will be performed consistent with Section 3.2.1 of this FSP.

Once the surface and downhole UXO avoidance activities are completed, the rotary drilling rig will be maneuvered into place over the cleared location for the purpose of installing a groundwater monitoring well.

3.3 MONITORING WELLS

3.3.1 MONITORING WELL INSPECTIONS AND INVENTORY

A survey of existing monitoring wells present in the AUS OU will be performed to document the condition of the existing monitoring wells. The well total depth will be compared with the original construction details. A summary of the existing monitoring well network and their locations is provided in the RI/FS Work Plan.

Each well will be inspected for the following items:

- well identification;
- guard post condition;
- protective casing condition;

- well cap condition;
- padlock condition;
- concrete pad condition;
- well total depth; and
- ground condition (subsidence or ponding).

The results of the well inspection will be noted, and the need for monitoring well repairs, redevelopment, abandonment, or replacement will be assessed. An example monitoring well inspection form is provided in Appendix B.

3.3.2 MONITORING WELL, PIEZOMETER, AND TEMPORARY WELL INSTALLATION

New overburden monitoring wells, piezometers, and temporary wells will be installed during the Phase I RI for groundwater sampling and/or hydraulic monitoring. Specific details on the number, rationale and locations of the new overburden monitoring wells, piezometers, and temporary wells are provided in Section 5.0 of the RI/FS Work Plan. The monitoring wells, piezometers, and temporary wells will be screened in overburden deposits just below the elevation where the water table encountered at each location. As such, the total depths of the monitoring wells will vary dependent upon the depth to the water table at each specific location. Figure 3.1 provides a typical monitoring well construction diagram for an overburden monitoring well.

Existing Site-specific geologic, chemical and hydrogeologic information will be available to all field staff and reviewed by the geologist prior to borehole advancement and monitoring well, piezometer, and temporary well installations.

Site-specific protocols for the installation of overburden monitoring wells, piezometers, and temporary wells are provided in SOP 5 (Monitoring Well, Piezometer, and Temporary Well Construction and Development) found in Appendix A.

3.3.3 MONITORING WELL PIEZOMETER, AND TEMPORARY WELL DEVELOPMENT

In order to establish good hydraulic communication with the water-bearing unit and reduce the amount of sediment in the monitoring wells, piezometers, and temporary wells, both newly installed and selected existing monitoring wells, piezometers, and temporary wells will be developed. Monitoring wells, piezometers, and temporary wells will be developed no sooner than 24 hours following the installation of the surface pad and outer protective casing. Monitoring wells, piezometers, and temporary wells will be sampled no sooner than 14-days after development.

Site-specific protocols for the development of overburden monitoring wells and piezometers/temporary wells are provided in SOP 5 (Monitoring Well Piezometer, and Temporary Well Construction and Development) found in Appendix A.

3.4 WELL GAUGING/HYDRAULIC MONITORING

Groundwater-level gauging will be performed at the newly installed piezometers and monitoring wells and at selected existing monitoring wells. Water levels will be obtained by measuring the distance from the top of the riser pipe to the top of the water column using an electronic water level meter. The depth to water will be measured from a fixed reference point on the north side of the well casing. Measurements will be obtained to ±0.01 foot accuracy. Prior to measuring water levels, a survey mark will be placed on the north side of the monitoring well/piezometer riser pipe for use as a future measuring point for hydraulic monitoring activities, and the elevation of this measuring point will be surveyed to an accuracy of 0.01 feet and referenced to UTM Zone 16 NAD 83 horizontal data system.

General procedures for measuring water/fluid levels are provided in SOP 6, Groundwater and Fluid Level Monitoring (Appendix A).

Depth to groundwater measurements will be recorded on the monitoring well gauging log form presented in Appendix B.

3.5 SURFACE WATER GAUGING

Staff gauges will be installed in several water bodies during the RI. The staff gauges will consist of a surveyed fixed reference point located above the water body from which the distance to the top of the surface water body can be measured using a calibrated electronic water-level meter. Such points could include a bridge deck spanning the surface water body or a metal post driven into the bottom of the surface water body.

The measuring point will be conspicuously marked and will be surveyed to an accuracy of 0.01 foot and referenced to Universal Transverse Mercator (UTM) Zone 16 NAD 83 horizontal data system. The distance from the surveyed reference point and the top of the surface water body will be recorded to the nearest 0.01 inch using the calibrated electronic water-level meter when groundwater levels are monitored. The elevation of the surface water body can then be determined at the staff gauge location by subtracting the measured distance from the reference point to the top of the surface water body from the surveyed elevation of the reference point.

Staff gauge measurements will be recorded on the monitoring well gauging log form presented in Appendix B.

3.6 RESPONSE TESTING

Single-well hydraulic response testing will be preformed on newly installed monitoring wells and selected existing monitoring wells identified in the RI/FS Work Plan to estimate the hydraulic conductivity of the overburden unit.

Site-specific protocols for performing single-well response tests are summarized in SOP 8 (Single-Well Response Tests) found in Appendix A.

3.7 SURVEYING

Proposed soil, sediment, and surface water sampling locations and proposed soil boring and monitoring well locations will be staked in the field and surveyed (easting and northing) using portable global positioning system (GPS) equipment. After sediment, surface water, surface soil, subsurface soil samples have been collected, the sample locations will be marked in the field with stakes, flags, or roofing nails and flagging tape for surveying. Any stakes removed during sampling will be replaced in the general sampling area to assist the surveying team in locating the roofing nail/flagging tape sample location markers. All final sampling locations will be surveyed by a surveyor certified in the State of Illinois to an accuracy of 0.1 foot for horizontal (x,y) coordinates and 0.01 foot for elevations (z coordinate). The ground surface, top of riser, and top of protective cover elevations will be surveyed for monitoring wells. Surveying will be done as soon as practicable to minimize loss of the sample markers from weathering, vegetation, of wildlife activities.

A professional land surveyor is to certify all survey locations. All spatial data will be delivered in ESRI ArcView shape files. The files must define a point, line or area according to the most appropriate data type for the entity being represented. The shape file will contain a metadata text file and legend (.avl). The horizontal data will be reported using the horizontal data system of UTM, Zone 16, NAD 83, in feet. The elevation data will be reported in feet based on the GRS-80 ellipsoid.

3.8 SOIL AND GROUNDWATER FIELD METERS

Soil and groundwater sampling activities during the RI are being conducted by CRA. CRA has a quality system, which has been audited, approved and registered to ISO 9001 since December 1999. The approved quality system includes requirements for employee training to ensure personnel are properly trained and supervised prior to conducted specific work tasks. The approved quality system also includes detailed work instruction specifying procedures for the management of inspection, calibration maintenance, and measurement, of test equipment. These work instructions include regular calibration procedures and maintenance of the equipment. These work instructions are in-place to ensure the collection of field measurements/data is accurate, defendable and reproducible. The work instructions also require personnel to be trained and familiar with the operation and use of field equipment.

The approved quality system also includes Field Data Record forms providing instructions for the calibration of field equipment prior to use in the field. Appendix C contains several of these Field Date Record forms. Calibration procedures for field equipment are instrument specific and are conducted in accordance with the manufacturer's instructions and procedures established by CRA. Field calibration procedures are independent of shop services, and are documented on the Field Data Record Forms (QSF-200 Series D and QSF-400 Series D) or in some other suitable manner (e.g., field book).

CRA will assign a field equipment manager to the Refuge project that will be responsible for ensuring CRA's field equipment maintenance, calibration, and documentation procedures are adhered to consistent with CRA's ISO 9001 requirements. A flow chart that describes CRA's field equipment maintenance and calibration procedures is provided in Figure 3.3.

4.0 FIELD SAMPLING PROTOCOLS

Several types of environmental media samples will be collected for chemical analysis during the investigation. Environmental media collected for laboratory analysis of chemical concentrations includes sediments, surface water, groundwater, and soil. Geotechnical soil samples will also be collected. Prior to mobilizing to an investigative location, the specific sampling locations will be marked in the field with stakes and orange flagging tape by the access team and the CRA/ENTRIX Field Supervisor or CRA Assistant Field Supervisor. Sediment, surface water, surface soil, subsurface soil, and groundwater samples collected will be logged on Sample Collection Field Sheets (Appendix B). Alternately, electronic forms may be used.

4.1 SEDIMENT AND SURFACE WATER

Specific details regarding the number, rationale, locations, and sampling details for the RI sediment and surface water sampling program are provided in Section 5.0 of the RI/FS Work Plan.

4.1.1 SEDIMENT SAMPLING

The detailed procedures for the sampling of sediment are found in SOP 0025-002, entitled "Standard Operating Procedure for Collecting Sediment Samples". Decontamination procedures for sediment sampling equipment are described in SOP 0025-004, entitled Standard Operating Procedure for Decontaminating Sediment Sampling Equipment. These SOPs are located in Appendix A. Alternate techniques may be used only if local conditions prohibit sediment coring. Sediment samples will be collected, placed in the appropriate container(s), as described in the QAPP, and sent to the laboratory for analysis.

The collection of sediment samples will be paired with the collection of surface water samples, whenever possible. At locations where both sediment and surface water samples are to be collected, the surface water samples will be collected prior to the collection of sediment to minimize the presence of disturbed sediment in the surface water sample. At locations where multiple sediment and/or surface water samples are to be collected from a flowing body of water (creek, stream, or active drainageway), sampling will be initiated at the downstream location and will proceed upstream to the farthest upstream location. This will minimize the potential impact to samples from upstream sediment disturbed during sampling activity. Once again, at each location, the surface water sample will be collected prior to the sediment sample.

Ephemeral ponds and ditches act as surface water and sediment sinks when the rain water and snow melt recedes. These water bodies will collect and concentrate the sediment wash load carried during such events. Many of these ephemeral ponds/ditches also receive surface water drainage from the past and presently operating facilities. Samples will be placed near the boundary of the area of concern, where constituents could enter the feature through a drainage pathway.

Each sample will be collected from the depositional area that is located nearest to the point of potential entry. These depositional areas are the locations where particle-associated constituents would most likely accumulate, and therefore represent the most conservative approach for identifying transport pathways. Study area ephemeral ponds and drainage pathways have been identified from aerial photos and verified with field observations. Sediments tend to accumulate over time, with the surface layer representing current Refuge conditions.

Sediment samples will be collected with a coring device whenever possible. Sediment sampling strategy will consist of targeting the top 6 inches of sediments at each location as the top 6 inches represents the zone most likely to contain biological receptors. Grab samples will be collected at the 0-6 inch depth unless there is not sufficient sample volume for the sample. If there is not sufficient sample volume while collecting grab samples, the samples will be composited to provide the minimum volume for laboratory analysis.

4.1.2 SURFACE WATER

Surface water samples will be collected as indicated in the RI/FS Work Plan. The detailed procedures for the sampling of surface water are located in SOP 0025-003, entitled "Standard Operating Procedure for Collecting Surface Water Samples". This SOP is located in Appendix A.

Three types of surface water bodies to be sampled include: impounded water (including selected portions of Crab Orchard Lake); drainage water in streams and/or ditches that exit an AUS OU site; and selected ephemeral ponds and depressions. Unless otherwise stated in the RI/FS Work Plan, surface water samples will be collected in order to meet Validation Level IV, in order to satisfy the requirements of the baseline ecological and human heath risk assessments.

Surface water sampling will be scheduled to correspond with worst-case exposure scenarios. For deep water bodies (i.e., Crab Orchard Lake and certain ponds) the worst case exposure conditions will be found near the water surface, where drainage pathways discharge into the water body, and near the sediment/surface water interface. Seasonal ponds and ephemeral streams will be sampled in early spring, when they contain water that has traveled across the Refuge. These samples will be scheduled before spring floods, if possible, to avoid dilution. The permanent water bodies will be sampled during mid-summer or early autumn when the water levels and flows are lowest. This schedule will also minimize potential dilution.

The sampler will face upstream and collect the sample without disturbing the sediment. Surface water samples will be collected prior to the collection of sediments at the same location as to avoid sediment disturbance. Water samples will be collected by immersing uncapped analytically clean sample bottles into the water body. Only non-preserved sample containers will be submerged into the water body. For those sample containers that contain preservative, a non-preserved sample container will collect a sub-sample of surface water and transfer the contents into the sample container with preservative. This procedure avoids cross-contamination among samples because only the dedicated sample bottle contacts the sample. For the RI, unfiltered metals samples will be collected for "total" chemical analysis, and a second sample will be filtered in the field for "dissolved" metals analyses. For samples being submitted for dissolved metals analysis, a peristaltic pump, disposable Teflon tubing, and disposable 0.45 µ filters will be used in the field for collection. This procedure will be used to address bioavailability by comparing the dissolved versus particulate-bound concentrations of analytes.

Directly after the collection of surface water samples, the temperature and dissolved oxygen of the water will be field measured using a Yellow Springs Incorporated (YSI™) Model 55 meter or the equivalent instrument. These field measurements will be conducted after the collection of surface water sample to avoid cross-contamination. Also, the following ancillary chemistry parameters will be collected after the surface water sample has been collected: pH, electrical conductivity, and oxidation/reduction potential (ORP), using direct-read meters.

4.2 SURFACE SOIL SAMPLING

At locations where surface soil sampling activity is concurrent with subsurface borings, soil samples will be collected from the 0- to 6-inch and the 6- to 24-inch depth intervals using the procedures detailed in Section 3.2.1. The soil sampling program is detailed in Section 5.0 of the RI/FS Work Plan.

Site-specific surface soil sampling procedures are described in SOP 4 (Surficial Soil Sampling) found in Appendix A).

4.3 GROUNDWATER SAMPLING

The groundwater sampling program is detailed in Section 5.0 of the RI/FS Work Plan. Existing analytical data and/or drilling observations will be used to assist in identifying impacted monitoring wells. Groundwater sampling efforts will be conducted in a manner where apparently unimpacted monitoring wells are sampled prior to sampling apparently impacted monitoring wells, where this information is known prior to sampling.

Monitoring wells will be sampled no sooner than 14 days after development. Site-Specific groundwater sampling protocols are provided in SOP 7, (Groundwater Sampling) found in Appendix A.

4.4 GROUNDWATER SCREENING SAMPLES

Groundwater screening samples will be collected during the Phase I RI. Details regarding the groundwater screening are included in Section 5.0 of the RI/FS Work Plan. The groundwater screening samples are intended to facilitate more efficient monitoring well placement and therefore reduce the number of monitoring well installation phases. Boreholes for the groundwater screening samples will be advanced using the DPT discussed previously.

DPT groundwater samples will be collected using a Geoprobe™ SP-15 sampler, or similar or by temporary well installations. The SP-15 sampler will be the preferred method for the collection of groundwater screening samples. However, the stratigraphy beneath the Refuge consists primarily of low permeability silt and clay and, as such, the SP-15 sampler may not be a practicable method of collection due to slow recharge rates. If slow recharge rates are encountered in an area, temporary wells will be installed to collect the groundwater screening samples. Temporary wells will be constructed using the same procedures outlined in SOP 5 for piezometers (see Appendix A).

Details regarding the procedures to be used to collect the groundwater screening samples are provided in SOP 7 (Groundwater Sampling) found in Appendix A.

The SP-15 Sampler will be equipped with a stainless well screen and well point sheathed in a 1.6 inch diameter probe rod that is attached to the leading edge of the tool string and advanced into the subsurface using the percussion hammer and hydraulic slides on the DPT vehicle.

5.0 ANALYTICAL PROTOCOLS

5.1 OVERVIEW

During the RI/FS program, soil, sediment, surface water, and groundwater samples will be collected for chemical analysis. Details regarding the number of samples to be collected are provided in the RI/FS Work Plan and the QAPP. Soil samples will also be collected for geotechnical analysis. The analytical methods to be used for the samples collected during the RI are summarized in the QAPP.

5.2 GEOTECHNICAL SAMPLING

During the RI soil samples will be collected and analyzed for several geotechnical parameters to assist with evaluating geology, and hydrogeology and to assist with evaluations of contaminant fate and transport. Geotechnical parameters include total organic carbon (TOC), soil pH, permeability, and grain size distribution. Geotechnical soil samples will be collected using either the DPT or HSA rigs. Geotechnical soil samples will be collected from the already proposed soil borings and from monitoring well and piezometer boreholes.

At least four samples for the geotechnical parameters will be collected from each of the AUS OU sites (two samples from above the water table and two samples from below the water table). These data will be used to further evaluate collected soil and groundwater chemical data with respect to contaminate fate and transport. Samples for TOC and pH will be collected from areas least likely to be impacted by historic manufacturing operations and from locations where signs of contamination are not observed. The need for additional soil pH data due to potential impacts from historic manufacturing operations will be evaluated following review of the Phase I soil data.

Permeability, TOC, and grain-size data will be collected to assist with the geologic and hydrogeologic evaluation of the AUS OU sites. The objective is to collect one sample for permeability and grain size from each of the major overburden stratigraphic units encountered beneath the AUS OU. The exact number of samples to be collected will be dependent upon to number of major stratigraphic units encountered.

Analytical methods for the geotechnical samples are as follows:

TOC	ASTM D2974-87
pH	SW-846 Method 9045 C
Permeability	ASTM D5084-90
Grain Size Distribution	ASTM D422/D1140

Collected geotechnical samples will be shipped to the project laboratory for analysis.

5.3 SAMPLE MANAGEMENT AND FIELD QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

5.3.1 SAMPLE LABELING

Sample labeling, handling, shipping, documentation, chain-of-custody, and quality assurance/quality control procedures are described in SOP 9, Sample Management and Field QA/QC (Appendix A).

The sample labels will include a unique sample identification number, the place of collection, the date of collection, and the analyses to be performed. The sample identification format for this investigation has been designed to uniquely identify each sample from each sampling program and event. This identification format is identical to the format used during the PA/SI.

An example of the sample format is as follows, and is described below:

AUS-0A2B-004-SL-005

AUS- 0A2B-004-SL-05:	All samples will have the "AUS" prefix;
AUS- 0A2B-004-SL-05:	The second part of the number identifies the AUS OU Site. The example describes Area 2B;
AUS- 0A2B-004-SL-05:	The third part of the number identifies the sample location within that Site;
AUS- 0A2B-004-SL-05:	The fourth part of the number identifies the media (SS=soil, SD=sediment; GW=groundwater; SW=surface water; SL=sludge). The fourth part also identifies a QC sample where appropriate (EB=equipment rinsate blank; AB=ambient blank; TB=trip blank);

AUS-0A2B-004-SL-05:	If applicable, the last part of the number identifies the sample depth in feet, to the nearest foot of the bottom of the sample interval. "0X" in the fifth position indicates a sample collected from the surface to a depth of 6 inches.

For samples of waste material and samples collected from drums, the fourth and fifth positions will be replaced by a four-digit descriptor such as "drum" for a drum sample. Duplicate sample locations will be numbered sequentially starting with 500. This will ensure that duplicate samples cannot be distinguished from the original sample at the laboratory. The notes taken in the field log will detail the original sample for which it is a duplicate.

Sample information will be written on the labels using waterproof, non-erasable ink. The adhesive labels will be secured to the bottle. The labels will be further secured to the sample container using wide clear tape over the label and completely around the container before packing in a cooler for secure label protection during transportation and at the laboratory. The sample team members will ensure that the clear tape is not placed across the cap of the sample container.

5.3.2 SAMPLE CONTAINERS AND HANDLING

Samples will be placed in appropriate sample containers, labeled, and properly sealed. Foam chips or bubble pack will be used to cushion sample containers. Samples will be kept cool by the use of ice. A trip blank will accompany each shipment of multiple groundwater and/or surface water samples submitted for analysis of VOCs. Samples will be shipped by commercial overnight courier to the project laboratory. Samples collected on a Saturday will be shipped with additional ice in the coolers. Samples collected late on Saturday, on Sunday, or on a holiday will be placed in coolers with extra ice. Sample hold-time will be evaluated prior to collecting samples on weekend or holidays. The coolers will be sealed, stored in a secure location, and shipped by the courier on the next business day. Two chain-of-custody seals will be placed over the lid on the front and back of each shipping cooler. The seal will secure the lid and provide evidence that the samples have not been tampered with en-route to the project laboratory. Clear tape will be placed over the chain-of-custody seals to ensure that they are not accidentally broken during shipment.

Upon receipt of the cooler by the project laboratory, the designated sample custodian will inspect the cooler. The condition of the cooler and seal will be noted on the chain-of-custody form. The sample custodian will then check the contents of the cooler against the information noted on the chain-of-custody form. If damage or discrepancies are observed, they will be duly recorded in the "remarks" column of the chain-of-custody form. The form then will be signed and dated. Moreover, any observed damage or discrepancies will be reported immediately to ENTRIX's project chemist for guidance.

5.3.3 CHAIN OF CUSTODY FORMS

Chain-of-custody (COC) forms will be completed for all samples collected. The form documents the transfer of sample containers. An example of a typical chain-of-custody is provided on Figure 5.1.

Each sample cooler being shipped to the laboratory will contain a chain-of-custody form. The chain-of-custody form will consist of four copies which will be distributed as follows: the shipper will maintain a copy while the other three copies will be enclosed in a waterproof envelop within the cooler with the samples. The cooler will then be sealed properly for shipment. The laboratory, upon receiving the samples, will complete the three remaining copies. The laboratory will maintain one copy for their records. The executed original will be returned to ENTRIX with the data deliverables package. Copies of the COC will also be provided to NewFields Companies, L.L.C. (NewFields) as well as a copy of the laboratory electronic data deliverable (EDD).

The chain-of-custody record, completed at the time of sampling, will contain, but not be limited to, the sample number, date and time of sampling, and the name of the sampler. The chain-of-custody document will be signed and dated by the sampler when transferring the samples.

The following list provides guidance for the completion and handling of all COCs.

i) COCs used should be those supplied by the project analytical laboratory (STL) or at a minimum contain at least the same information as STL's. (No COCs forms from other labs will be used, even if the heading is blocked out.)

ii) COCs must be completed in black ball-point ink only.

iii) COCs must be completed neatly using printed text.

iv) If a simple mistake is made, line out the error with a single line and write initials and date next to it.

v) Each separate sample entry must be sequentially numbered.

vi) The use of "Ditto" or quotation marks to indicate repetitive information in columnar entries should be avoided. If numerous repetitive entries must be made in the same column, place a continuous vertical arrow between the first entry and the next different entry.

vii) When more than one COC form is used for a single shipment, each form must be consecutively numbered using the "Page ___ of ___" format.

viii) If necessary, place additional instructions directly onto the COC. Do not enclose separate loose instructions.

ix) Include a contact name and phone number on the COC in case there is a problem with the shipment.

x) A copy of the COC must be maintained in the field site file.

xi) Do not indicate the source of the sample as this may produce a biased lab result.

xii) Before using an acronym on a COC, define clearly the full interpretation of your designation [e.g., Polychlorinated Biphenyls - (PCBs)].

Upon receipt of the cooler by the project laboratory, the designated sample custodian will inspect the cooler. The condition of the cooler and seal will be noted on the chain-of-custody form. The sample custodian will then check the contents of the cooler against the information noted on the chain-of-custody form. If damage or discrepancies are observed, they will be duly recorded in the remarks column of the chain-of-custody form. The form then will be signed and dated. Moreover, any observed damage or discrepancies will be reported immediately to the project chemist for guidance.

5.4 QUALITY CONTROL

To ensure the validity of data from the sampling and analysis program, field QC samples will be collected and submitted for analysis. Field QC samples will consist of field duplicate samples, field equipment rinsate blank samples, trip blank samples, matrix spike/matrix spike duplicate (MS/MSD). Field QC samples will be collected at the frequencies specified in the QAPP. Field duplicates will be collected at a rate of one per 20 investigative samples. Field equipment rinsate blank samples will be collected at a frequency of one per 10 investigative aqueous samples and one per 20 investigative soil/sediment samples.

Trip blank samples will be prepared by the laboratory, shipped with the sample containers, and returned unopened to the laboratory in sample coolers containing multiple aqueous samples for VOC analysis. MS/MSD samples will be collected at frequency of one per 20 investigative samples. MS/MSD groundwater samples will be collected from a well representative of the condition of the majority of the monitoring wells. The chain-of-custody forms sent to the project laboratory will identify the samples collected for MS/MSD analysis. Additional sample volume will be provided as necessary to the laboratory for MS/MSD analysis. MS/MSD samples are investigative samples that are analyzed by the laboratory to evaluate analytical accuracy and precision relative to the sample matrices. The QA/QC procedures for the laboratory analyses are provided in the QAPP.

5.5 ANALYTICAL LABORATORY

Solid and aqueous samples collected for this investigation will be analyzed by STL. STL-North Canton will analyze samples for the following parameters: target analyte list (TAL) metals (and boron), target compound list (TCL) VOCs and semi-volatile organic compounds (SVOCs) (including other project-specific/organic constituents of concern), TCL organochlorine pesticides, PCBs, polynulclear aromatic hydrocarbons (PAHs) by selective ion monitoring (SIM), total cyanide, alkalinity, TOC, pH, ammonia, nitrate/nitrite, phosphorous/orthophosphate, methane/ethene/ethane, sulfate, sulfide, total dissolved solids (TDS) and total suspended solids (TSS).

STL-North Canton's contact information is:

4101 Shuffel Drive N.W.
North Canton, OH 44720
Phone: (330) 497-9396

STL-Sacramento will analyze samples for: explosives and perchlorate. STL-Sacramento's contact information is:

880 Riverside Parkway
Sacramento, CA 95605
Phone: (916) 373-5600

STL-Burlington will analyze samples for geotechnical parameters, specifically permeability and grain size. STL-Burlington's contact information is:

208 South Park Drive
Suite 1
Colchester, VT 05446
(802) 655-1203

The organophosphorous pesticide analyses will be performed by Pacific Agricultural Laboratory (PAL) out of Portland, Oregon. Pacific Agricultural Laboratories contact information is:

12505 Northwest Cornell Road
Portland, Oregon 97229
(503) 626-7943

6.0 HEALTH AND SAFETY PLAN

A site-specific Health and Safety Plan (HSP) has been developed to address activities to be performed at the AUS OU. All field activities will be conducted in accordance with the health and safety protocols outlined in the HSP. The HSP is presented in a separate document.

A safety briefing will be conducted in the field for all personnel prior to the start of each day's activities.

7.0 FIELD MANAGEMENT PLAN

7.1 ROLES AND RESPONSIBILITIES

GD-OTS through their law firm, Jenner and Block, retained NewFields in May 2002 to serve as Owner's Agent/Program Manager in the negotiation of the Administrative Order on Consent (AOC) and manage execution of the RI/FS. GD-OTS also retained ENTRIX to provide ecological risk assessment support work for the RI/FS, CRA to conduct field services (drilling, data collection, UXO clearance, and surveying), and Severn Trent Laboratories (STL) for chemical analysis. The various quality assurance (QA) and management responsibilities of key project personnel are defined below.

7.2 PROJECT ORGANIZATION CHART

The project organization chart for this project can be found as Figure 2.1 of the QAPP.

7.3 MANAGEMENT RESPONSIBILITIES

The project management and responsibilities for this project can be found in Section 2.2 of the QAPP.

7.4 QA RESPONSIBILITIES

QA Managers – Cheryl Randle (ENTRIX) and Charlene Rivard (NewFields)

The QA Managers will be responsible for ensuring that all QA/QC procedures for this project are being followed. The QA Managers will review and approve the QAPP. The QA Managers will monitor sample techniques and collection, will address any corrective action or issue that may arise with the analytical laboratory, and will oversee the data validation process of all sample results from the analytical laboratory. The QA Managers will also perform internal and external performance and system audits. The audit process will include but not be limited to auditing field sampling techniques and auditing the analytical laboratory and data validation firm.

7.5 FIELD RESPONSIBILITIES

Conestoga-Rovers & Associates (CRA) Project Manager – Steven Wanner

The CRA Project Manager has responsibility for ensuring that the project meets the USEPA's, the IEPA's, and the FWS' objectives and CRA's quality standards. The CRA Project Manager will provide assistance in terms of revising and distributing the RI/FS Work Plan, QAPP, and FSP to all those parties connected with the project. The CRA Project Manager is responsible for technical QC and project oversight. Specifically, the CRA Project Manager has responsibility for overall management of the sampling of soil and groundwater and survey activities and ensuring appropriate CRA resources are devoted to the project.

CRA Field Supervisor – Walt Pochron

The CRA Project Manager will be supported by the CRA Field Supervisor. The Field Supervisor is responsible for leading and coordinating the day-to-day activities of the various resource specialists assigned to the collection of groundwater and soil samples. The CRA Field Supervisor will report directly to the CRA Project Manager.

Specific Field Supervisor responsibilities include the following:

- responsible for the day-to-day coordination with the CRA Project Manager on technical issues in specific areas of expertise;
- developing and implementing field-related Work Plans, assurance of schedule compliance, and adherence to management-developed study requirements;
- coordinating and managing of field staff including sampling and drilling;
- acting as field sample custodian;
- implementing of QC for technical data provided by the field staff including field measurement data;
- adhering to work schedules provided by the CRA Project Manager;
- authoring, writing, and approving of text and graphics required for field team efforts;
- coordinating and overseeing technical efforts of subcontractors assisting the field team;
- identifying problems at the field team level, resolving difficulties in consultation with the CRA Project Manager, implementing and documenting corrective action

procedures, and provision of communication between team and upper management; and

- participating in preparation of the final report.

CRA Field Technical Staff

The CRA technical staff (team members) for this project will be drawn from CRA's pool of corporate resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

ENTRIX Consulting Field Supervisor – B.J. Seagrist

The ENTRIX Project Manager will be supported by the ENTRIX Field Supervisor. He is responsible for leading and coordinating the day-to-day activities of the various resource specialists under his supervision with specific regard to the collection of surface water and sediment. The ENTRIX Field Supervisor will report directly to the ENTRIX Project Manager. Specific Field Supervisor responsibilities include the following:

- Responsible for the day-to-day coordination with the ENTRIX Project Manager on technical issues in specific areas of expertise;
- Developing and implementing of field-related work plans, assurance of schedule compliance, and adherence to management-developed study requirements;
- Coordinating and managing of field sampling staff;
- Acting as field sample custodian;
- Implementing of QC for technical data provided by the field staff including field measurement data;
- Adhering to work schedules provided by the ENTRIX Project Manager;
- Authoring, writing, and approving of text and graphics required for field team efforts;
- Coordinating and overseeing technical efforts of subcontractors assisting the field team;
- Identifying problems at the field team level, resolving difficulties in consultation with the ENTRIX Project Manager, implementing and documenting corrective action

procedures, and provision of communication between team and upper management; and
- Participating in preparation of the final report.

<u>ENTRIX Consulting Field Technical Staff</u>

The ENTRIX technical staff (team members) for this project will be drawn from ENTRIX's pool of corporate resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

7.6 FIELD SUBCONTRACTORS

Subcontractors will be required in order to complete field investigative tasks. This section identified key field subcontractors that will assist with implementation of the field work. These subcontractors may change based upon timing of the fieldwork and subcontractor availability. In the event of a change in the subcontractors is required, the name and qualifications of the alternative subcontractor(s) will be provided to the Agencies for prior approval.

7.6.1 DRILLING

Geoprobe®/DPT and light rig HSA services will be provided by:

Altech Services L.L.C.
37663 Schoolcraft Road
Livonia, Michigan 48150
(734) 432-1600

Rotary drilling services will be provided by:

Boart Longyear Company
Environmental Drilling Division
101 Alderson Street
P.O. Box 109
Schofield, Wisconsin 54476
(715) 359-7090

7.6.2 UXO AVOIDANCE

UXO avoidance services will be provided by:

EOD Technology, Inc.
2229 Old Highway 95
Lenoir City, Tennessee 37771
(865) 988-6063

7.6.3 UTILITY LOCATING

Utility locating services will be provided by the Illinois JULIE One-Call Service.

A local private locating service will be retained on an as needed basis.

Utility locates will coordinated with GD-OTS and the FWS Maintenance Supervisor.

7.6.4 SURVEYING

Surveying services will be provided by:

CRA Services
14496 Sheldon Road
Suite 200
Plymouth, Michigan 48170
(734) 453-5123

Sampling locations will be surveyed by a surveyor certified in the State of Illinois. A number of existing known points at the Refuge will be surveyed as a QA/QC Check.

7.7 CONTACT INFORMATION

7.7.1 GENERAL PROJECT CONTACTS

Project personnel involved with the field investigation effort, roles, and contact information are listed below:

GD-OTS On-Refuge	Susan Taylor	(618) 993-9465
Project Manager on Behalf of GD-OTS	Dave Trainor	(608) 442-5223
NewFields Database Manager	Gil Dunn	(865) 777-0275
CRA Project Manager	Steven Wanner	(317) 381-0677
CRA Field Supervisor	Walter Pochron	(773) 380—9933 or Office Trailer During Field Activities
CRA Database Manager	Julie Lidstone	(519) 884-0510
ENTRIX Project Manager	Jody Kubitz	(847) 842-1882
ENTRIX Field Supervisor	B.J. Seagrist	(847) 842-1882
USEPA Project Manager	Nanjunda Gowda	(312) 353-9236
FWS AUS OU Coordinator	Leanne Moore	(618) 998-5907
IEPA Project Manager	Paul T. Lake	(217) 785-7728

The above list will be updated as necessary during the course of the project. This list will be kept by the CRA Field Supervisor and will be posted near the field office trailer telephone during the major field effort.

7.7.2 EMERGENCY CONTACTS

Emergency contact information is provided in Section 15.0 of the HSP.

8.0 FIELD DOCUMENTATION AND DATA MANAGEMENT PLAN

During day-to-day field activities, field data will be generated that will require management pursuant to this FSP. Examples of field data that will be generated during the project include:

- stratigraphic observations;
- monitoring well/piezometer construction information;
- groundwater levels;
- monitoring well purging/development parameters;
- environmental media sampling information (i.e., PID readings, sample type, sample location, sample depth intervals, sample numbers, observations, etc.);
- GPS coordinates; and
- survey data.

Field documentation and data management procedures described herein will ensure all relevant field data are properly recorded and disseminated for evaluation.

8.1 FIELD DOCUMENTATION PROTOCOLS

Methods of documenting activities conducted during the RI are discussed herein.

8.1.1 FIELD LOGBOOK

A summary of activities performed at the AUS OU will be recorded in field logbooks. The field logbooks will be bound with consecutively numbered pages. The entries for each day will commence on a new page, which will be dated. All entries will be in non-erasable ink and corrections will be made by marking through the error with a single line, so as to remain legible, and initialing this action followed by writing the correction. Upon completion of the fieldwork or during periods when fieldwork is not scheduled, the field logbooks generated will be numbered consecutively and maintained in CRA's Indianapolis, Indiana and ENTRIX's Barrington, Illinois offices.

The following information will be recorded in the field logbook:

i) Site personnel present;

ii) time and date;

iii) equipment calibration activities undertaken and results;

iv) weather conditions;

v) type of work being performed and location of the work;

vi) type of equipment used;

vii) time of day tasks were begun and completed;

viii) any pertinent observations or description of unusual conditions;

ix) difficulties or problems encountered;

x) description actions taken or direction given to resolve a situation;

xi) results of inspection activities;

xii) contractors, subcontractors, and government agencies present on site;

xiii) decontamination activities; and

xiv) any other relevant or pertinent comments related to field work.

It is the responsibility of the CRA/ENTRIX Field Supervisor to ensure that field personnel are properly documenting the work in the field logbooks.

8.1.2 FIELD FORMS

Field forms to be used to record data and observations are presented in Appendix B. Field forms to be used are as follows:

- all samples collected will be recorded on a Sample Collection Field Sheet (alternately and electronic version of the form my be used);
- all samples will be shipped under chain-of-custody forms;
- subsurface soil will be logged in accordance with the Unified Soil Classification System (USCS) and recorded on an Overburden Stratigraphic Log form;
- monitoring well and piezometer construction will be logged on a Monitoring Well Construction form;
- water level measurements will be recorded on a Water Level Records form (alternately and electronic version of the form my be used);
- monitoring well purging data will be recorded on a Monitoring Well Record for Low-Flow Purging form (alternately and electronic version of the form my be used); and

- UXO data will be recorded in field books and on maps.

Alternately to using field forms, soil and groundwater sampling, water level, and purging data also may be recorded electronically on CRA's eMonitor system.

8.2 DISSEMINATION OF FIELD DATA

8.2.1 ENVIRONMENTAL SAMPLE RECORDS

Field data collectors will record sample data and information on Sample Collection Field Sheets (alternately and electronic version of the form my be used). Additionally, chain-of-custody forms will be completed for all environmental samples shipped from the Refuge. The CRA/ENTRIX Field Supervisor will ensure that the chain-of-custody forms for the day's sampling activity are transmitted on a daily basis by electronic mail or telefacsimile to ENTRIX's Project Chemist, NewField's Database Manager, and CRA's Database Manager. ENTRIX's Project Chemist will be responsible for confirming sample receipt at the laboratory and coordinating sample analyses. In the event there is a problem with the samples received by the project laboratory, ENTRIX's Project Chemist will immediately communicate the problem to the CRA/ENTRIX Field Supervisor so that corrective actions can be developed and implemented to correct the problem.

Stratigraphic logs and monitoring well construction records will be submitted to CRA's Database Manager for entry into software for production of stratigraphic and instrumentation logs. CRA's Database Manager also will ensure that data from other filed forms is entered into the project's electronic database. Figure 8.1 presents the flow of data from sample collection through reporting.

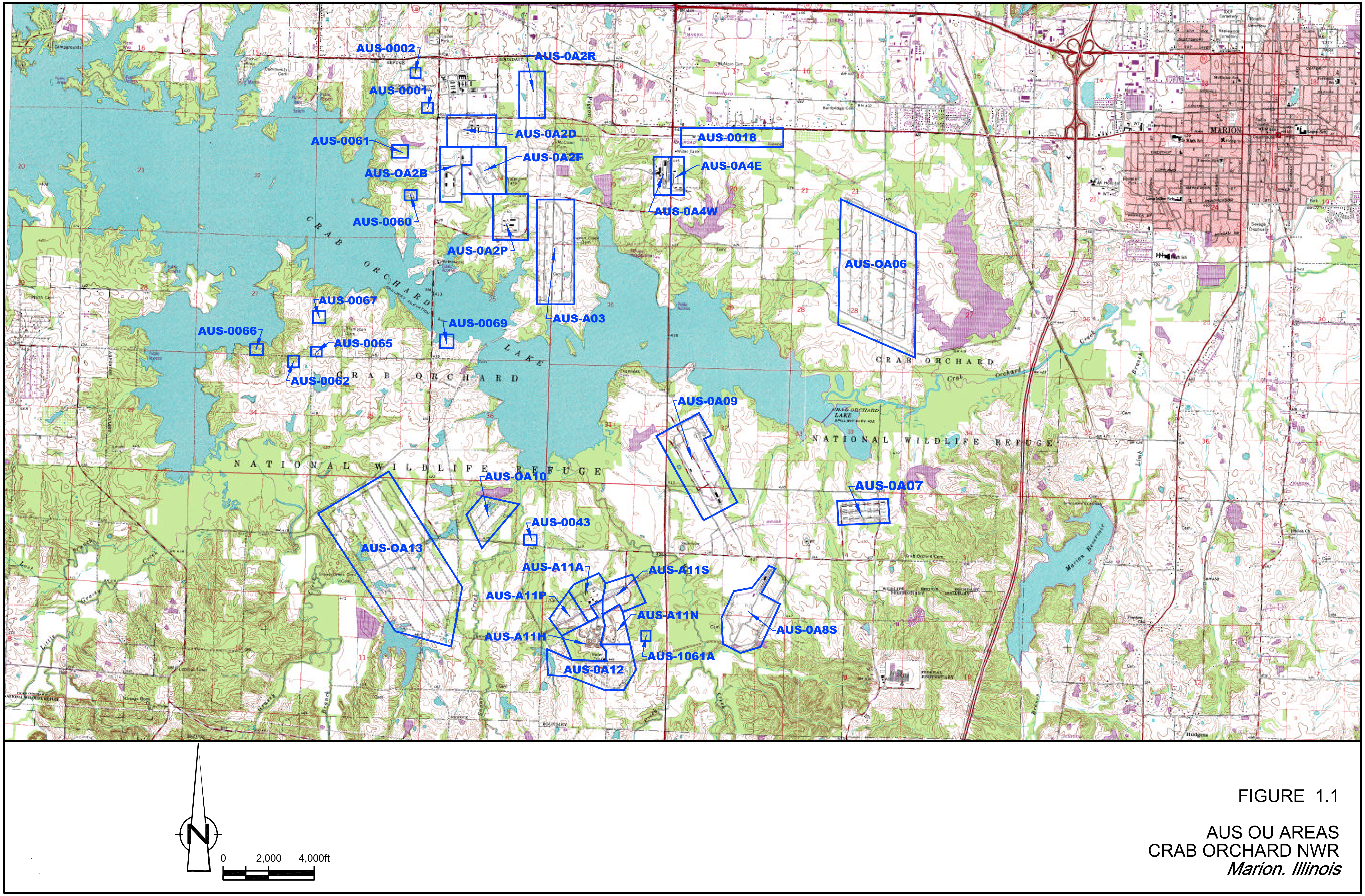


FIGURE 1.1

AUS OU AREAS
CRAB ORCHARD NWR
Marion. Illinois

31756-10(002)GN-CO005 AUG 17/2005

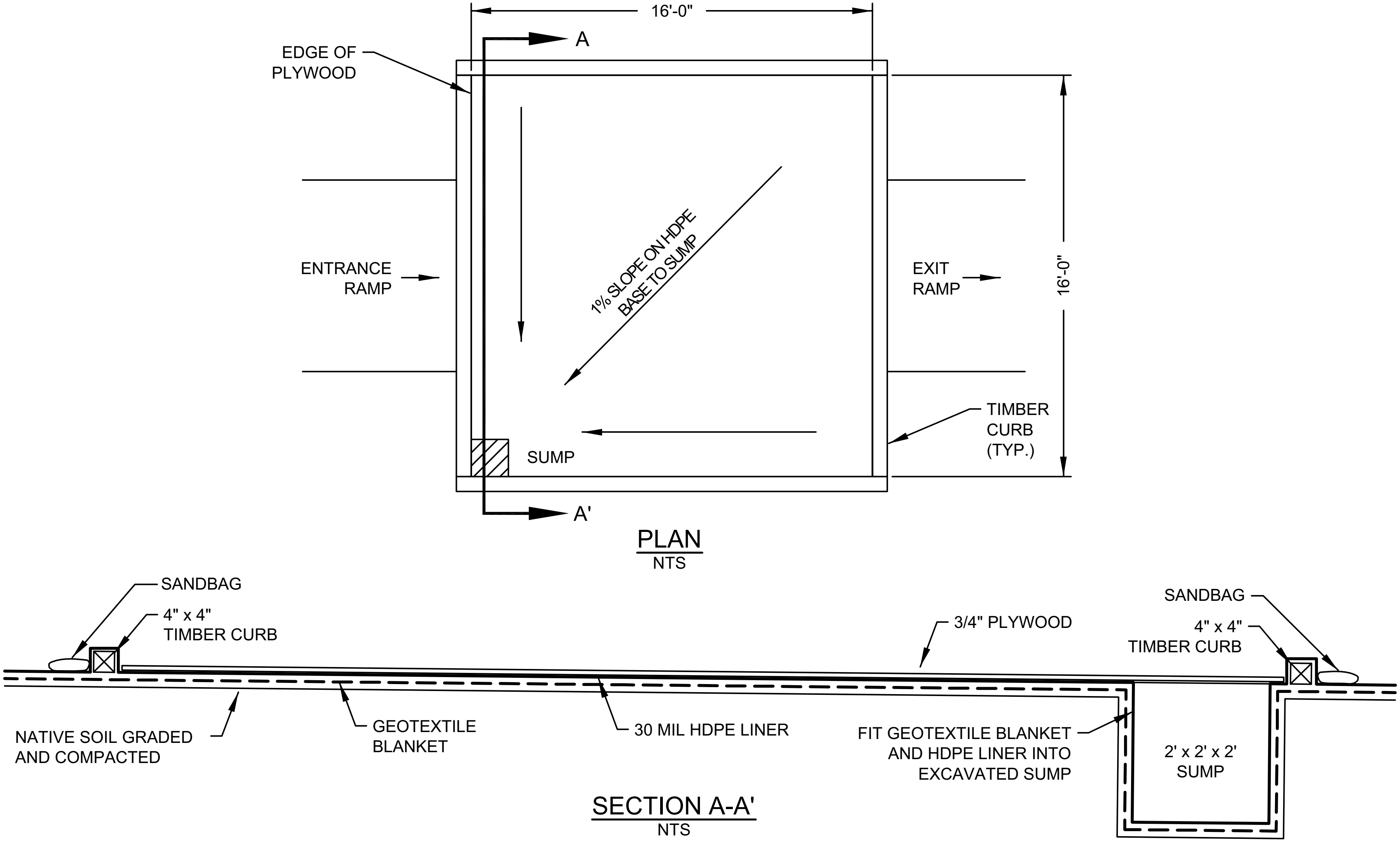
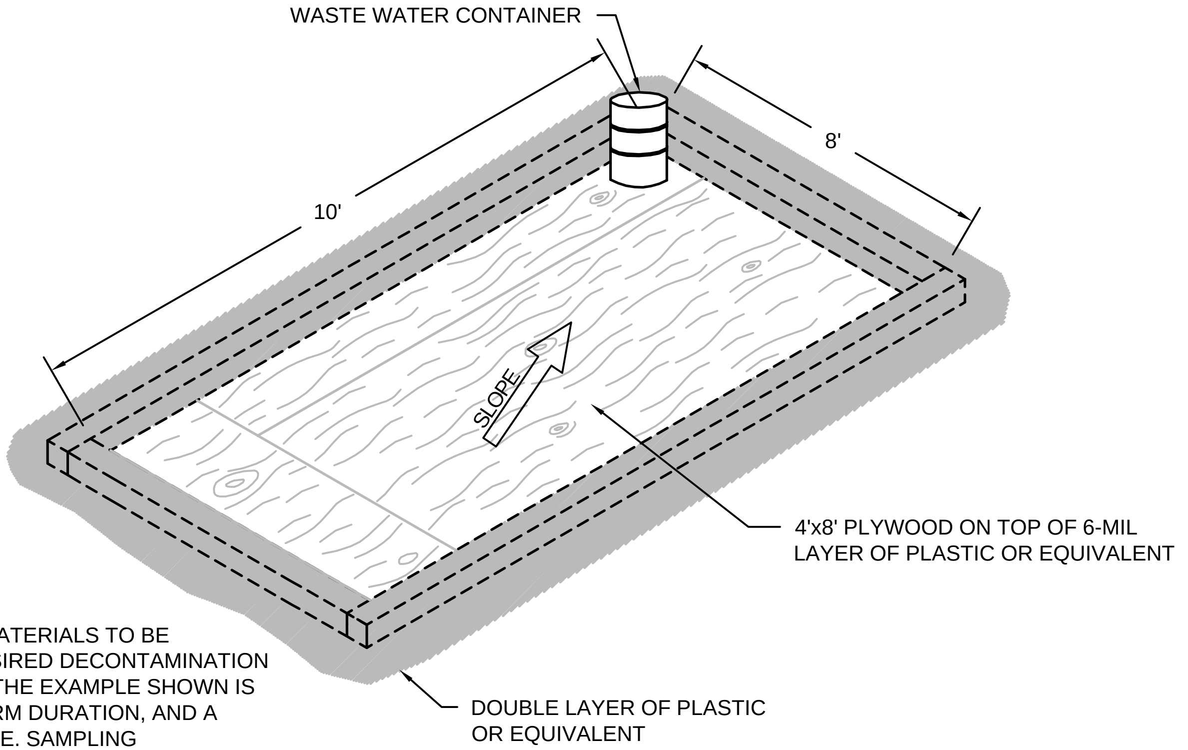


FIGURE 2.1

CENTRAL DECONTAMINATION PAD DETAIL
CRAB ORCHARD NWR
Marion, Illinois

NOTE:

THE PAD SHOWN IS A TEMPORARY (I.E. SHORT TERM) MEDIUM DUTY USE DESIGN.



NOTE:

SIZE AND CONSTRUCTION MATERIALS TO BE DETERMINED BASED ON DESIRED DECONTAMINATION AREA USE AND DURATION. THE EXAMPLE SHOWN IS INTENDED FOR A SHORT TERM DURATION, AND A LIGHT DUTY APPLICATION. (I.E. SAMPLING EQUIPMENT, DRILLING TOOLS, AUGERS) PLYWOOD TO USED AS SIDE SHIELDS

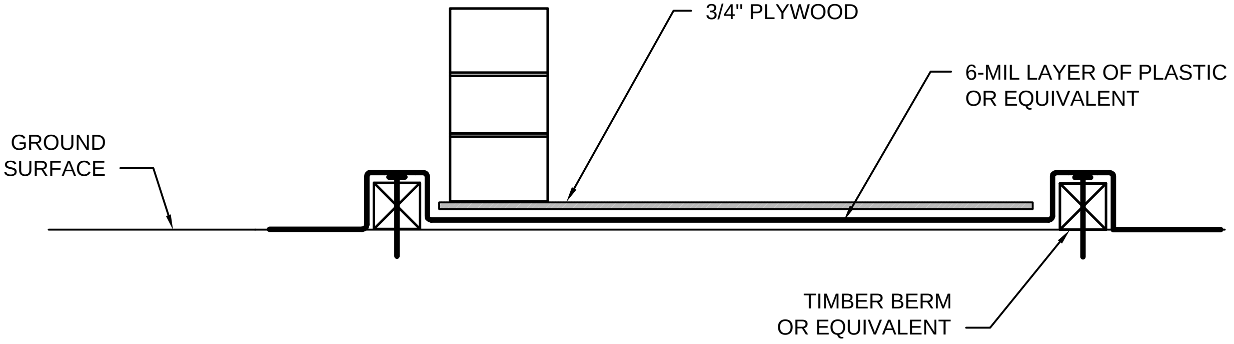


FIGURE 2.2

TEMPORARY RIG/HSA DECONTAMINATION PAD
CRAB ORCHARD NWR
Marion, Illinois

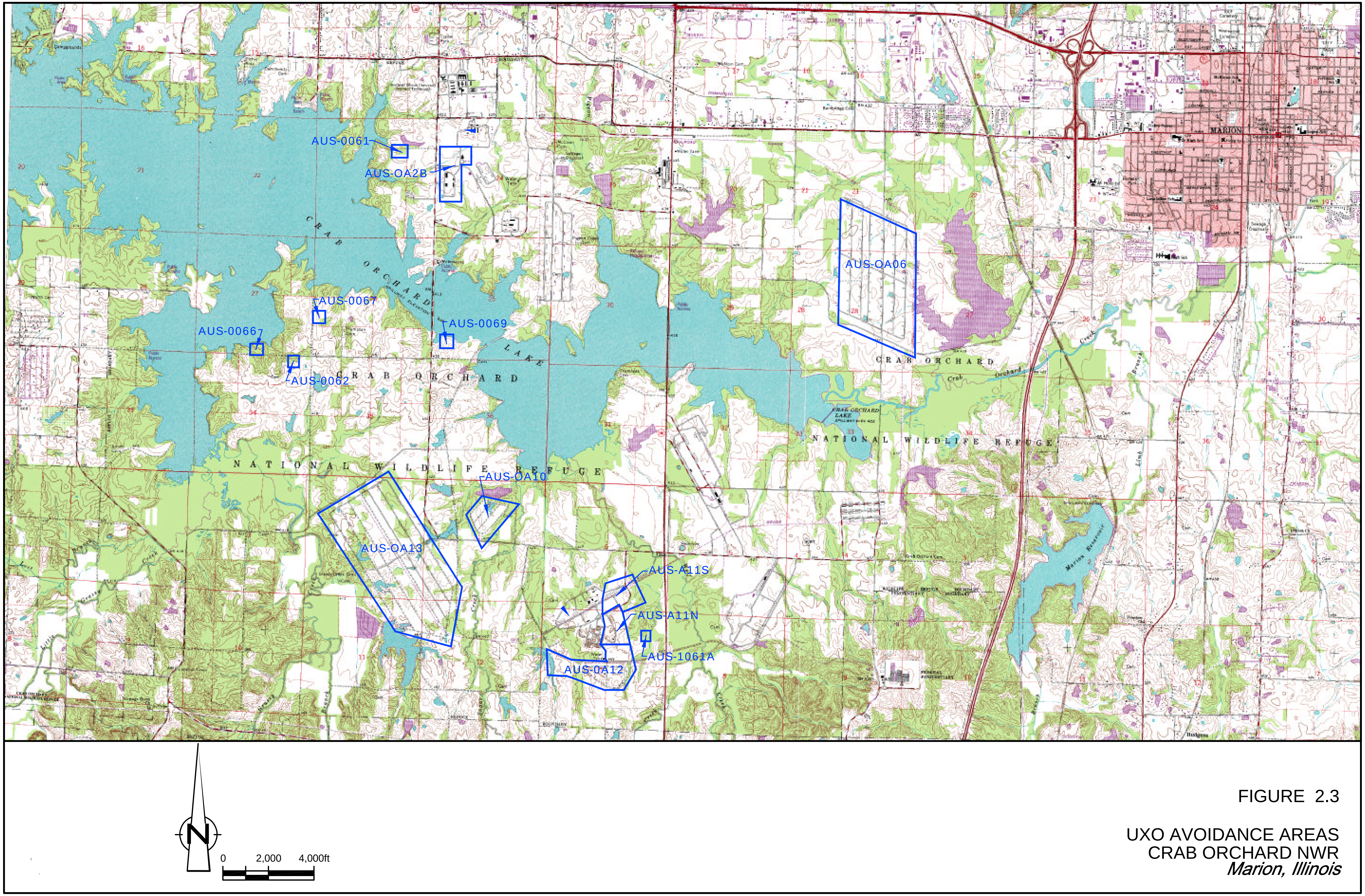


FIGURE 2.3

UXO AVOIDANCE AREAS
CRAB ORCHARD NWR
Marion, Illinois

31756-10(002)GN-CO006 AUG 17/2005

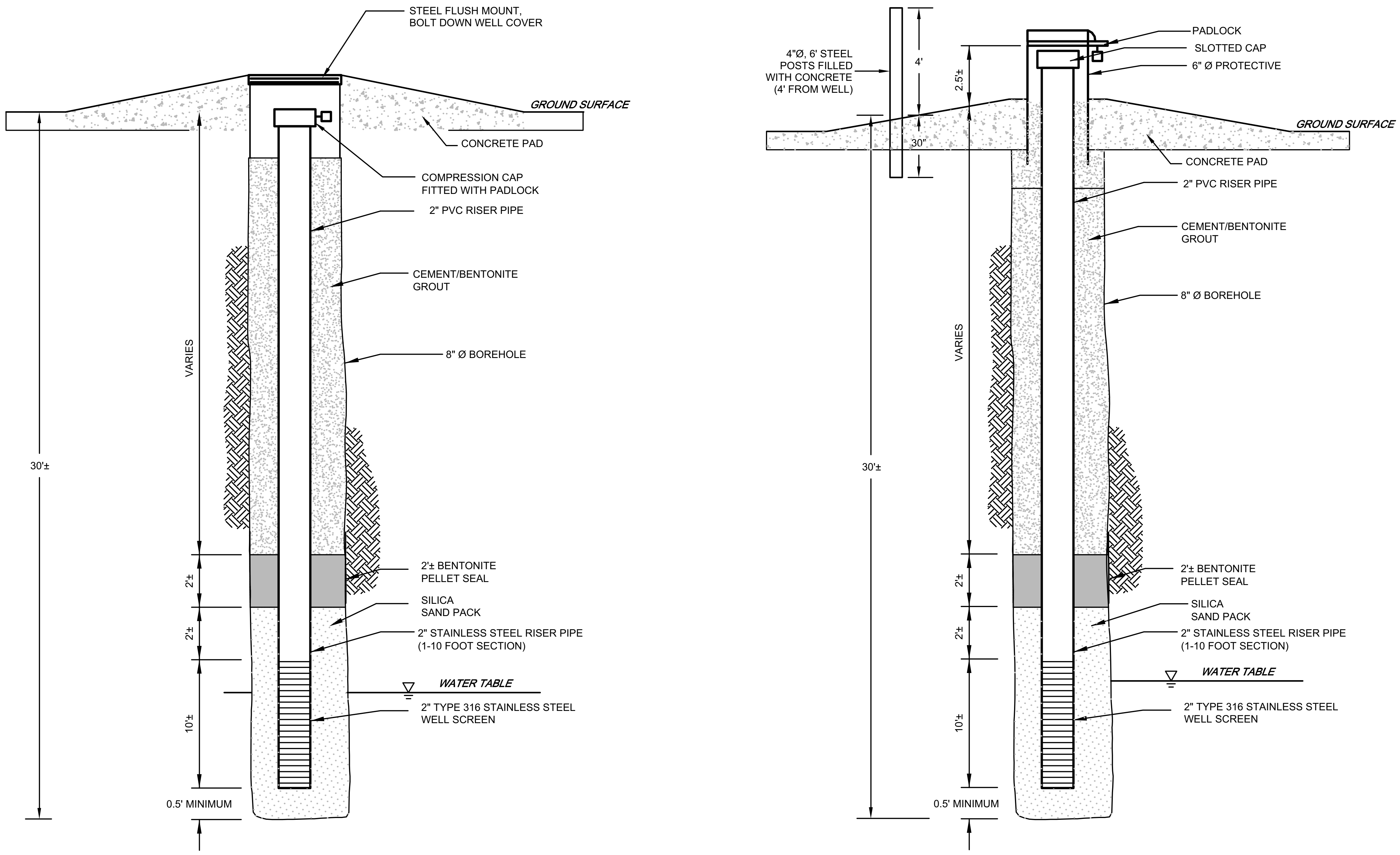
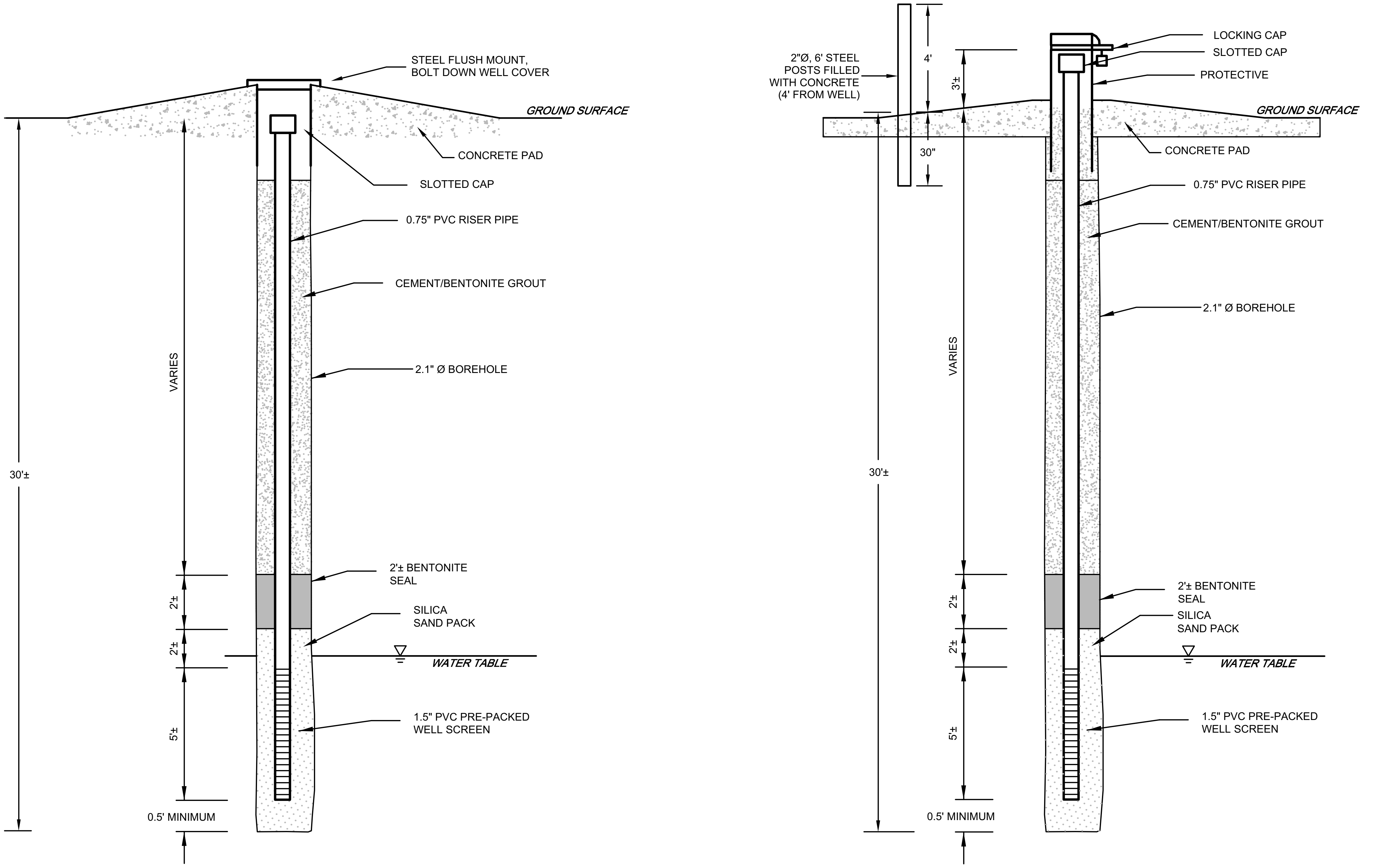


FIGURE 3.1

TYPICAL OVERBURDEN
MONITORING WELL INSTALLATION DETAIL
CRAB ORCHARD NWR
Marion, Illinois



NOTE:

PROTECTIVE CASING AND BALLARD POST
WILL NOT BE INSTALLED ON TEMPORARY WELLS

FIGURE 3.2

TYPICAL OVERBURDEN PIEZOMETER/TEMPORARY WELL
INSTALLATION DETAIL
CRAB ORCHARD NWR
Marion, Illinois

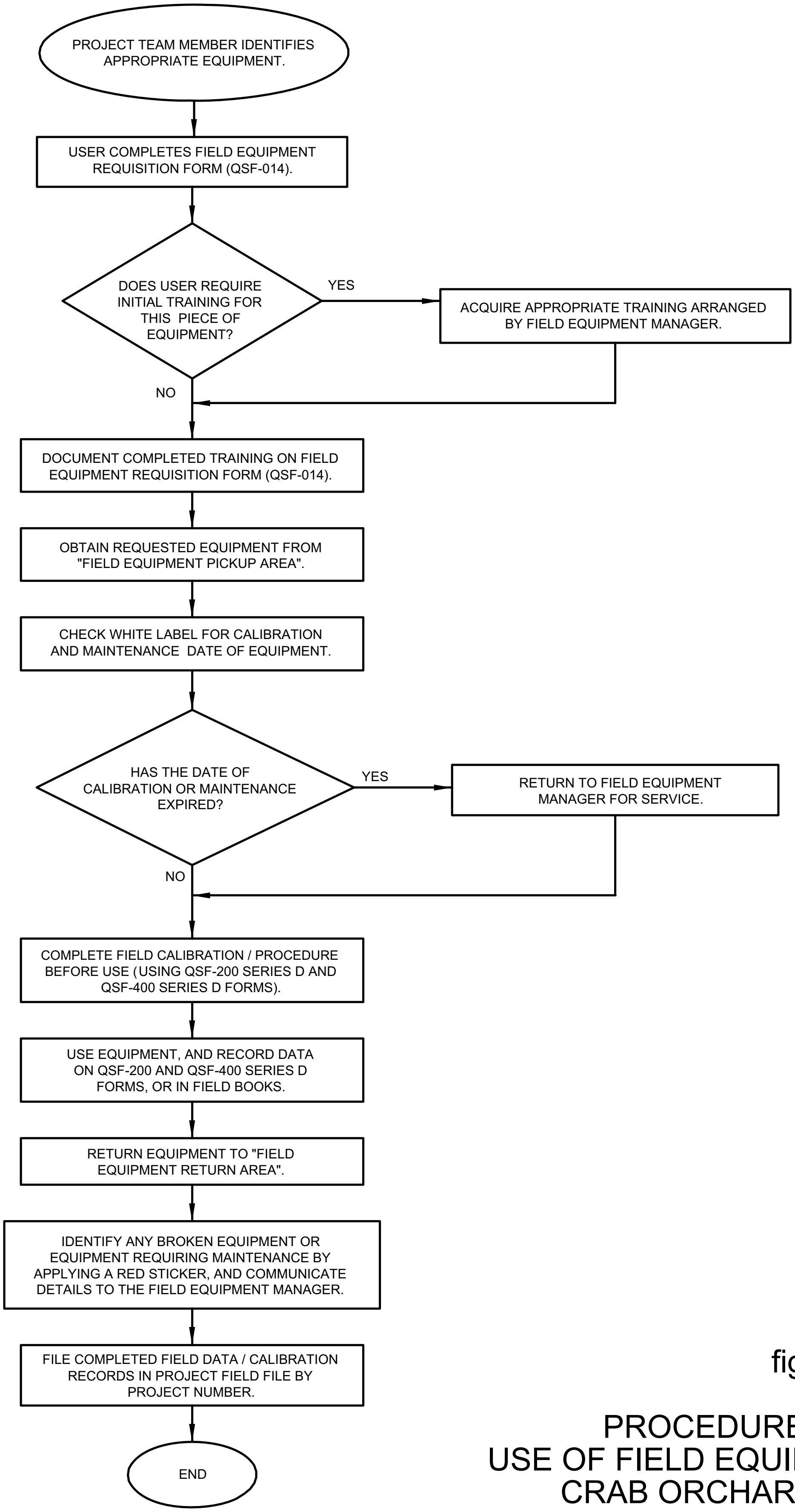
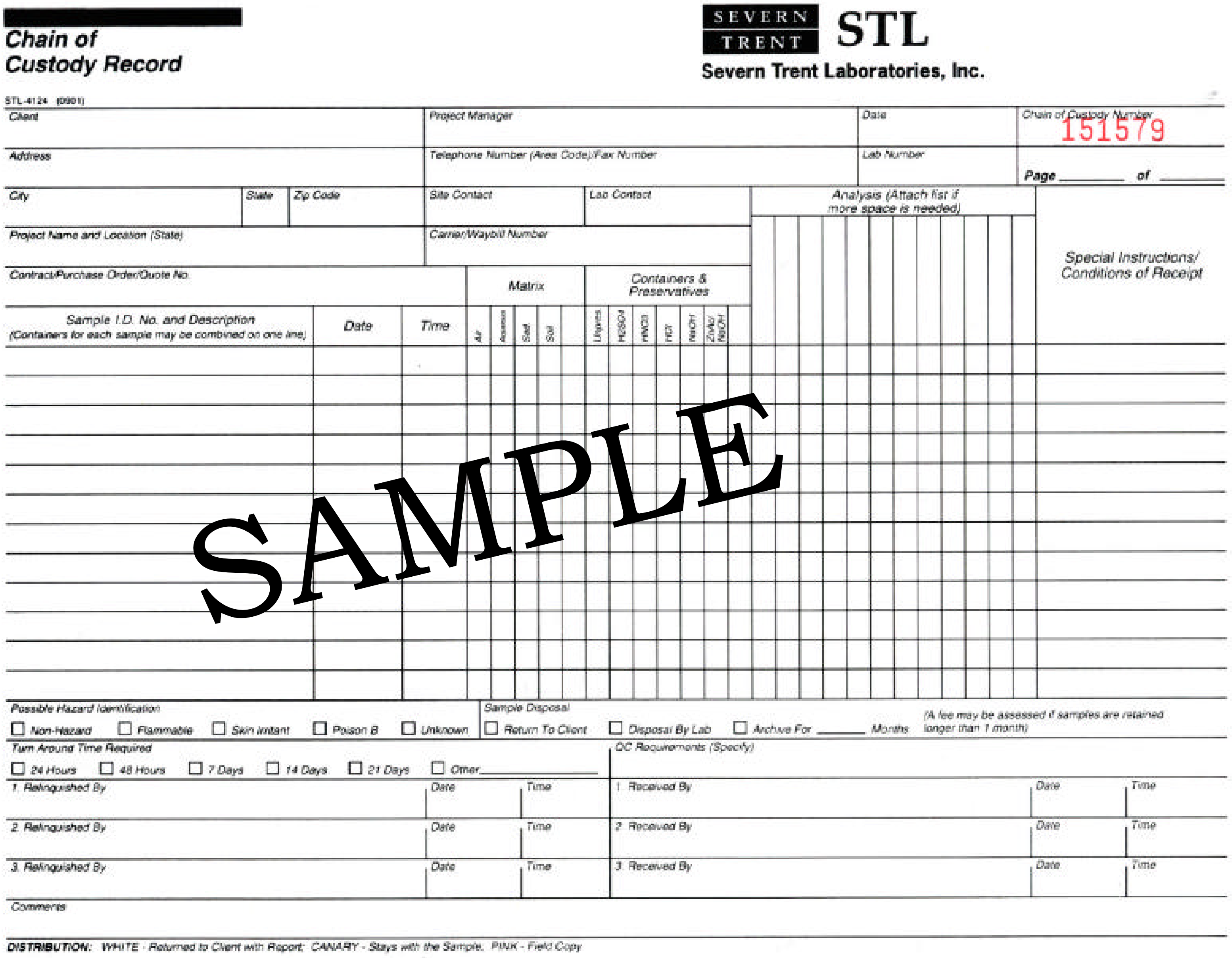


figure 3.3

PROCEDURES FOR
USE OF FIELD EQUIPMENT
CRAB ORCHARD NWR
Marion, Illinios



Chain of Custody Record

SEVERN TRENT STL
Severn Trent Laboratories, Inc.

STL-4124 (0901)

Client
Project Manager
Date
Chain of Custody Number 151579
Address
Telephone Number (Area Code)/Fax Number
Lab Number
Page ______ of ______
City
State
Zip Code
Site Contact
Lab Contact
Analysis (Attach list if more space is needed)
Project Name and Location (State)
Carrier/Waybill Number
Contract/Purchase Order/Quote No.
Special Instructions/ Conditions of Receipt

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix					Containers & Preservatives					
			Air	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH

SAMPLE

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other ______

QC Requirements (Specify)

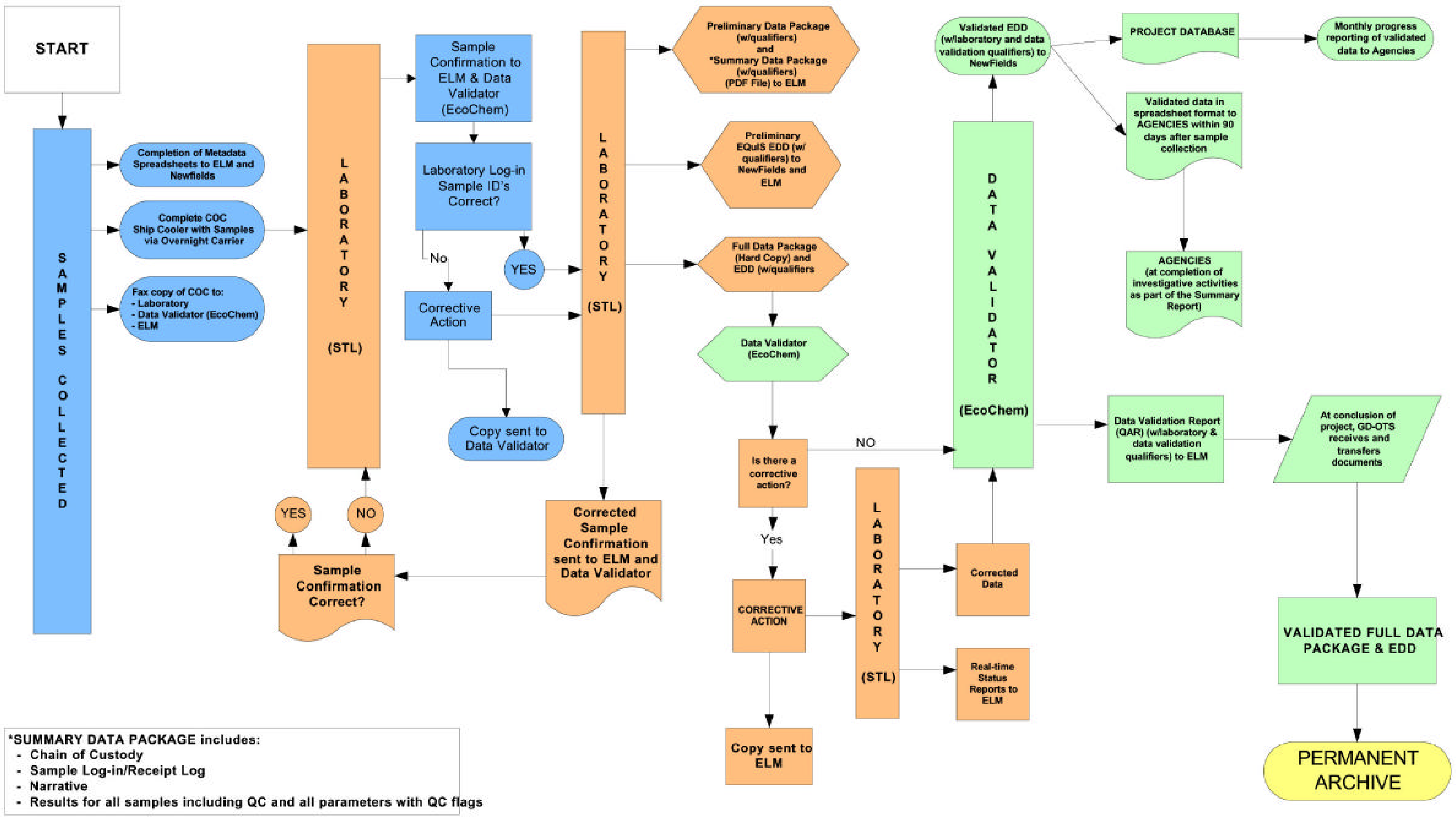
1. Relinquished By Date Time
1. Received By Date Time
2. Relinquished By Date Time
2. Received By Date Time
3. Relinquished By Date Time
3. Received By Date Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

FIGURE 5.1

TYPICAL CHAIN-OF-CUSTODY RECORD
CRAB ORCHARD NWR
Marion, Illinois



*SUMMARY DATA PACKAGE includes:
- Chain of Custody
- Sample Log-in/Receipt Log
- Narrative
- Results for all samples including QC and all parameters with QC flags

figure 8.1

DATA MANAGEMENT FLOWCHART
CRAB ORCHARD NWR
Marion, Illinois

Standard Operating Procedure for Collecting Sediment Samples

1 Scope & Summary:

This standard operating procedure outlines techniques for collecting sediment samples from shallow freshwater streams, ponds, inland lakes, drainage pathways and ephemeral water bodies. This method is described for deployment from a small, stable boat or on foot.

Sediment samples are collected using a core sampler, and samples are placed into clean, labeled jars with minimum headspace and packed in ice (in coolers) during transportation to the laboratory. If no water is present in sampling locations that are only temporarily inundated, then a trowel will be used to collect the sediment sample.

2 Reference Documents:

ASTM (E1391-90) *Standard guide for collection, storage, characterization and manipulation of sediments for toxicological testing*. American Society for Testing and Materials, Annual Book of ASTM Standards. vol. 11.02, Philadelphia, PA.

Baudo, R (1990) *Sediment sampling, mapping and data analysis*. In Sediments: the Chemistry and Toxicology of In-place Pollutants. R Baudo, J Giesy & H Muntau (eds.). Lewis Publishers. Chelsea, MI pp. 15-60.

Mudroch, A & S MacKnight (1994) *Bottom sediment sampling. In Handbook of Techniques for Aquatic Sediments Sampling*. Second Edition. A Mudroch & S. MacKnight (eds.) Lewis Publishers, Ann Arbor, MI pp. 29-96.

USEPA (1985) *Sediment sampling quality assurance user's guide*. EPA 600/4/85/048. U. S. Environmental Protection Agency, Environmental Monitoring and Support Lab., Las Vegas, NV 114 pp.

3 Significance and Use:

The samples collected by this method are suitable for chemical characterization, but may not be suitable for biological analyses such as benthos characterization. This method is best for studies where sample replication is desired. Samples of the same depth interval and cross-section can be collected from each location, or a sample transect can be used.

4 Potential Interferences:

4.1 The sediment surface can be easily disturbed during sample collection. This disturbance will increase the turbidity of the overlying water and might cause errors in the analytical chemistry data. Therefore, caution must be exercised, especially when using the T-handle, to avoid disruption of the sediment-water interface.

4.2 The presence of headspace (bubbles) in sample containers might cause errors in the analytical chemistry data. Extra care must be taken to completely fill sample containers, especially those to be analyzed for volatile substances.

4.3 Residual sediment might remain in the core sampler and contaminate subsequent samples. To prevent contamination, all sampling gear must be thoroughly decontaminated between sample locations.

4.4 Large objects (e.g. stones, sticks etc.) might obstruct the core barrel and prevent successful sample collection. If possible, sample locations should be selected to avoid these objects.

4.5 It might be difficult to penetrate very firm sediments (e.g. clay, gravel, or sand) with the core sampler. A pre-sampling site inspection should be conducted to evaluate the suitability of the sample gear for collecting samples.

4.6 The materials of which the core sampler is composed could contaminate the samples. To minimize potential contamination, the equipment that contacts the sample should be assembled using the materials least likely to result in contamination. For example:

- Samples for metals analyses should be collected with plastic equipment. The core samplers are built of stainless steel, however, plastic liners, cutting heads, retainers, extruders, knives and compositing bowls should be used.
- Samples for analysis of organic compounds should be collected with stainless steel liners, cutting heads, retainers, extruders, knives, and compositing bowls should be used. If a stainless steel extruder is not available, a brass extruder may be used.

4.7 Care must be taken to avoid having the sample or sample container come into contact with the ungloved hand or clothes of the sampler. The sampling team must always wear sterilized sampling gloves appropriate for the specific media and constituents being analyzed. During sampling, if the sample container or sample comes into contact with the ungloved hand or clothes of the sampler, it is assumed that the sample has been cross-contaminated and a new sample container must be used or the location must be re-sampled.

5 Apparatus:

5.1 The Wildco sediment core sampler (or equivalent) consists of a steel cylinder fitted with a sharp nose piece and a “T” handle. This cylinder (core barrel) contains a replaceable plastic (cellulose acetate butyrate) or stainless steel liner that stabilizes the sediment sample, and a (eggshell) core retainer that prevents the sample from exiting the liner. A check valve above the core barrel allows air and water to escape when the device is pushed into sediment, but closes during retrieval to prevent the sample from escaping. The Wildco sampler (or equivalent) can be used in shallow (< 15 feet) waters.

5.2 The K-B sediment core sampler (or equivalent) has the same barrel, liner, nosepiece, and core retainer. The check valve assembly has been modified to avoid backpressure within the core barrel. This design prevents the K-B core sampler from disturbing the sediment-water interface. The K-B corer also has a heavy weight (36 kg) affixed below the check valve that facilitates penetration into the sediments. It has no T-handle to push it into the sediments, but relies on weight. The K-B corer is operated with an 1/8 inch aircraft cable. It is designed to free-fall the last 30 feet (10 m) of the water column. A messenger is used to close the check valve once the core has penetrated the sediments. The K-B corer (or equivalent) is suitable for water depths < 600 feet (provided enough cable is attached).

5.3 If no water is present in ephemeral water bodies, then a metal or plastic trowel will be utilized to collect the sample. The composition of the trowel will be dependent upon the type of constituents to be analyzed (Section 4.6).

6 Materials:

- Wildco core sampler (or equivalent) (core barrel with check valve and T- handle);

- K-B core sampler (or equivalent) (core barrel with check valve, aircraft cable and winch);
- core liners with end caps: for organic analyses stainless steel liners and end caps will be used, and for inorganic analyses cellulose acetate butyrate (CAB) liners and HDPE end caps will be used. (Note: end caps will only be used if field conditions require that sample cores be transported prior to extrusion);
- core nose pieces;
- core retainers;
- core extruders;
- spatulas or knives;
- compositing vessels;
- sample containers with lids;
- sample labels;
- sample trowel;
- dissolved oxygen meter and probe with depths pre-marked on cable (YSI Model 57 DO meter (or equivalent) with 25 feet of (unmarked) cable can be rented from Hazco);
- pH meter and probe;
- specific conductance meter and probe with depths pre-marked on cable (YSI Model 33 conductivity meter (or equivalent) with 25 feet of (unmarked) cable can be rented from Hazco);
- temperature meter and probe with depths pre-marked on cable (YSI Model 57 DO meter (or equivalent) with 25 feet of cable can be rented from Hazco);
- waterproof marking pens;
- coolers (with ice) for sample storage;
- core-holding buckets;
- sample data forms/clip board;
- decontamination supplies;
- nitrile gloves;
- pipe wrench (minimum 14 inch) to disassemble corers;
- miscellaneous tools (vise grip pliers, shackles, wrenches, plumber's Teflon thread tape, utility knife);
- messenger for K-B corer;
- camera and film or disks; and
- personal & safety gear;

7 Hazards & Precautions:

7.1 Field-collected sediments might contain potentially toxic materials, and thus should be treated with caution to minimize exposure to workers. Waterproof clothing (waders) and gloves are recommended.

7.2 The project Health and Safety Plan must be reviewed to identify further hazards, precautions and safety procedures.

8 Sample Preparation:

8.1 Sample locations may be adjusted on-site as deemed necessary by the location of sedimentation zones, physical obstructions, or other factors. A pre-sampling site inspection should be conducted to evaluate whether these procedures are feasible (Section 4.5 & Section 10.2) for sampling the desired locations.

8.2 Appropriate new sample containers must be obtained from the analytical laboratory or a commercial supplier. The analytical procedures must be reviewed to identify the proper sample container material, size, and preparation.

8.3 The Field Team Leader must read the Quality Assurance Project Plan before field sampling procedures are undertaken to understand how many and what type of QA/QC samples are required.

8.4 The Field Team Leader and sampling staff must read the Health and Safety Plan prior to sampling to review applicable safety requirements.

9 Preparation of Apparatus

9.1 All sampling equipment (core samplers, liner tubes, caps, eggshell catchers, etc.) must be cleaned with a laboratory-grade detergent (Alconox ® or equivalent) and rinsed with laboratory grade deionized water (if inorganics are the suspect contaminant) or organic free water (if organics are the suspect contaminant); Because additional preparations (acid or solvent rinses) might be necessary for specific analyses, the analytical methods should be reviewed to identify additional requirements.

9.2 The field meters and probes should be calibrated and tested.

9.3 Slits should be cut in the end caps for the core tubes to allow air to escape, and prevent disturbance of the sediment cores (sec. 11.5).

9.4 The core samplers should be field-tested to ensure the check valves are working properly.

9.5 The core sampler should be assembled using the appropriate contact material (plastic or stainless steel) as described in Section 4.6.

10 Calibration & Standardization

10.1 The field meters (pH, dissolved oxygen, and specific conductance) must be calibrated according to the manufacturer's manuals.

10.2 The sediment extruder should be calibrated to facilitate the removal of a pre-selected volume of sediment from the core liner. A pre-sampling field inspection (sec. 8.1) should be conducted to determine the practical minimum depth the corer will penetrate (sec. 4.5) into the sediments at the site. All sediment samples should then be collected to this (minimum) depth so the analytical results will be comparable.

10.3 The extruder post should be calibrated (marked) so that the amount of sediment extruded can be selected. This procedure ensures that the same amount of sediment is extruded from each core so that samples are consistent and comparable. A small snap-type clamp can be used to mark the point of maximum extrusion so that the field personnel can focus their attention on capturing the surficial sediment layer as it is extruded. In most sediments this layer will be very flocculent and can easily be lost.

10.4 The K-B corer (or equivalent) is heavy, awkward to grasp, and relatively sensitive to jostling. It can't be operated with a hand-over-hand technique along the cable. Arrangements must be made to raise and lower it with a winch-pulley-roller system from a davit or tripod. The deployment design should be pre-assembled and tested before sampling is attempted. The deployment device will be specific to the actual boat, barge or other watercraft used, and cannot be prescribed in this SOP.

11 Procedure

11.1 Identify the sample location from the sampling map.

11.2 Assemble the coring device, and make the necessary preparations to collect samples from the marked sample stations. Sediment samples will be collected with a coring device whenever possible. Sediment sampling strategy will consist of targeting the top 6 inches of sediments at each location as the top 6 inches represents the zone most likely to contain biological receptors. Samples will be collected at the 0-6 inch depth unless there is not sufficient sample volume for the sample. If there is not sufficient sample volume from a particular sample point then samples will be composited to provide the minimum volume for laboratory analyses. When sampling from a boat or barge, preparations to secure the boat with anchors must be made. It is highly recommended that a davit or tripod structure, with the necessary winch and pulleys be used to raise and lower the K-B corer (or equivalent). It is heavy, awkward to grasp, and relatively sensitive to jostling. It cannot be operated with a hand-over-hand technique along the cable. These arrangements will be specific to the actual boat, barge or other watercraft used, and cannot be prescribed in this SOP.

If a ephemeral water body is being sampled and no water is present, make the necessary preparations to collect samples with a trowel. Because no water is present, no ancillary field measurements will be collected. Insert the trowel into the sediment approximately 4 cm and place material into homogenizing vessel. Continue sampling and adding material to the homogenizing vessel into an appropriate amount is collected. Continue to Section 11.11.

11.3 Collect ancillary field measurements (depth, pH, dissolved oxygen, temperature, specific conductance). When wading, this should be done in an area immediately downstream of, or away from the sampling site. When sampling from a boat, this should be done at the deepest point along the transect.

11.4 Collect sediment samples with the core sampler. Press the Wildco core barrel (or equivalent) into the sediment with a constant pressure. If the sediment is firm, the sampler may be twisted in a clockwise manner to increase penetration. Retrieve the core sampler (lift vertically) when the core barrel has been inserted its full length into the sediment (or can't be inserted further as described in sections 4.5 and 10.2). When using a K-B corer (or equivalent), lower the corer with the aid of a winch. Once the corer has ceased to descend, the messenger is clipped to the cable and released. When the messenger closes the check valve there will be an audible click, and the corer can be retrieved using the winch.

11.5 Remove the sediment sample from the core barrel. Have one person stand and hold the device vertically while a second person unscrews the nose piece, then carefully lift the core barrel off the core liner (which now contains the sediment sample. Carefully place end caps over both ends of the core liner. (The end caps may force air into the sediment core and disturb the sample; the end caps can be slit (sec. 9.3) to allow the air to escape). Set the core sample (in a vertical position) aside for extrusion. Rinse the core barrel with site water and reassemble with a new liner (and retainer), and continue sampling.

11.6 Decontaminate sampling equipment, including the pH and specific conductance meter probes, the spatula, the core barrel, and nose piece.

11.7 Extrude the sediment core(s) from the liner tube(s).

11.8 One person retrieves a core from a core-holding bucket and removes the top cap. Cut a slit along the side of the bottom cap to allow for easier removal but make sure that the bottom cap is still secure.

11.9 Carefully remove the bottom cap from the core liner, then remove the retainer.

11.10 Immediately insert the extruder into the bottom of the core liner to prevent the sediment sample from escaping. Push the extruder up into the core barrel (1/2 cm at a time) and scrape the extruded sediment sample into the compositing vessel. This process is repeated for each sampling point that is sampled per sampling location, and the extruded sediment for each sampling point is added to the compositing vessel.

11.11 The sampler will note and record the depth of the soil/sediment interface,

11.12 Homogenize the composted sediment in the compositing vessel. Fill the appropriate sample bottles, and store on ice. Samples for volatiles should be filled completely. Air bubbles are not desirable because they could facilitate loss of compounds from the media of concern and bias sample results.

11.13 Decontaminate the equipment to be re-used. For metals analyses, the plastic core liners, trowels and eggshells are inexpensive, and can be discarded. Stainless steel equipment is much more expensive, however, it is also very durable and easy to decontaminate.

12 Calculations: Not Applicable

Applicable Forms

Sediment Sampling Field Data Sheet

Field Audit for Sediment Sampling

Audit Finding Record

Photograph Log

Maintenance Log

ENTRIX

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Barrington, IL 60010

Sediment Sampling Field Data Sheet

Equipment Used: **Sample Type:** **Grab** **Composite**

"Grab" samples consist of more than one sample point per sample location. Composite samples consist of more than one sampling location.

Project No.	Location Description		
Sampling Personnel		GPS Personnel	
Sampling Date/Time (dd-mon-yy/military)		GPS Date/Time (dd-mon-yy/military)	
Polygon Name			
Transect ID (line)		Sample_ID (point)	
Field Descriptions & Observations			
Sunny ☐	Partly Sunny ☐	Cloudy ☐	Raining ☐
Calm ☐	Slightly Windy ☐	Windy ☐	Gusting Winds ☐
Ambient Air Temperature (°C): _______________			
Specific conductance (μmhos)		Water temperature (°C)	
pH		Dissolved oxygen (mg/L)	

Sediment samples collected (check)			
	volatile organic compounds		Polynuclear aromatic hydrocarbons
	semi-volatile organic compounds		Selective Ion Monitoring
	TAL metals/cyanide		Polychlorinated biphenyls
	total organic carbon		PH
	particle size distribution		Other ____________________

Photo date/time (dd-mon-yy/military)	Disk ID	No. of photos already used:

Frame	Direction	Photo ID	Frame	Direction	Photo ID

Shaded cells must match attribute names used in GPS Data Dictionary.

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Audit Checklist for Sediment Sampling

Project Description	Field Team Leader
Project No.	Audit Date
Sampling personnel	Audit No.

Audit Question	S	U	N/A	comments
Were all personnel briefed on their assignment?	☐	☐	☐	
Did the crew have all the forms and maps, equipment and materials necessary to complete the assigned tasks?	☐	☐	☐	
Were the sampling locations correctly identified on the forms?	☐	☐	☐	
Were the field meters properly calibrated?	☐	☐	☐	
Were samples collected according to the procedure and all potential interferences addressed before sampling?	☐	☐	☐	
Was the depth of the sediment samples consistent?	☐	☐	☐	
Were sample locations properly marked for the survey crew?	☐	☐	☐	
Were the sampling equipment and meter probes properly cleaned between sample locations?	☐	☐	☐	
Were all sample containers properly labeled?	☐	☐	☐	
Were all sample containers properly filled (e.g. no head space)?	☐	☐	☐	
Were all samples properly packed for shipping?	☐	☐	☐	
packed in ice?	☐	☐	☐	
custody seals in appropriate places?	☐	☐	☐	
Did personnel adhere to the safety procedures?	☐	☐	☐	

Auditor Signature: ____________________

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800 Hart Road, Ste. 250
Barrington, Illinois 60010

Audit Finding Report

Project No.	Task No.	Audit No.	Audit Date
Individual(s) contacted		Auditor Signature	
Requirements			
Findings			
Recommended Corrective Action			
Scheduled Response Date		Responsible for Corrective Action	
Corrective Action Taken			
Date	*Submitted by*	*Management Approval*	
Date Response Received		Response Acceptable? Yes No	
Reason for Rejection			
Verification			
Date Verified		Auditor Signature	

ENTRIX

800 Hart Road, Ste. 250
Barrington, Illinois 60010

Photograph Log

Project Description		Field Team Leader	
Project No.	Task No.	Photos By	
Date(s)		Location	
Film Type		Roll/Disk # of	
Frame	Subject/Sample ID	Frame	Subject/Sample ID
1		19	
2		20	
3		21	
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14		32	
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16		34	
17		35	
18		36	

Maintenance Log

Manufacturer:	In-Service Date:
Model No:	Replacement Date:

S/N:

Contact Information:

Location:

Date	Service Type	Serviced by:	Notes:

Standard Operating Procedure for Collecting Surface Water Samples

1 Scope & Summary:

This protocol outlines techniques for collecting surface water from shallow, freshwater streams, ponds and drainage pathways for chemical analyses. This method is described for deployment by personnel that are wading, but the techniques may also be applied from a small, stable boat.

Water samples are collected by immersing sample bottles below the water surface. Samples are placed into clean, labeled jars with minimum head space and packed in ice (in coolers) during transportation to the laboratory.

2 Reference Documents:

USEPA (1982) *Handbook for sampling and sample preservation of water and wastewater.* EPA-600/4-82-029. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati OH 402 pp.

3 Significance and Use:

The samples collected by these methods are suitable for chemical characterization, but may be inadequate for biological analyses such as benthos and/or plankton characterization.

4 Potential Interferences:

4.1 When sampling sediments in conjunction with surface water sampling, the surface (overlying) water samples must be collected before the sediment samples. The sediment surface will most likely be disturbed during sediment sample collection. This disturbance will increase the turbidity of the overlying water and might cause errors in the analytical chemistry data.

4.2 The presence of head space (bubbles) in sample containers for volatile and semi-volatile compounds might cause errors in the analytical chemistry data. Extra care must be taken to completely fill these sample containers. Full sample containers should be inverted to check for bubbles.

4.3 When possible, all water samples should be collected upstream of the sampling team when the sampling team must enter the water by foot or by boat to collect the sample. Disturbance of the sediments by the sampling team could potentially generate a surface water sample that is not representative of the sampling location and yield unreliable data.

4.4 The collection of ancillary field measurements (pH, dissolved oxygen, temperature, specific conductance) should occur after the collection of surface water. Also, ancillary measurements should be collected downstream and away from the surface water sampling location. The collection of ancillary field measurements could potentially disturbed the sediment in the vicinity of the surface water sampling location and cause errors in the analytical chemistry data.

4.5 The sampling team will don the proper sterile sampling gloves so that the sampling container and/or sample will not come into contact with the skin of the sampler. Utilizing this procedure in the field minimizes the chances of the sample becoming contaminated by the sampler and yield unreliable data. Additionally, the wearing of sterile gloves provides a layer of protection to the sampler from potential dermal hazards while sampling.

4.6 If the water body to be sampled is shallow, the sampling team should avoid disturbing the sediments with the sample container. If the sample container cannot be completely submerged into the water body, the sampling team should use a small sample container to collect the sample as to not disturb the underlying sediment. The sample water can then be transferred into the appropriate container for shipment to the laboratory. When sampling with 40ml glass vials with preservative, the sample vials will not be submerged in the water. Instead a separate 1-liter amber glass container will be used to collect the sample water and fill the 40ml glass vial. This is important so as to not lose the preservative within the 40 ml glass vial.

5 Apparatus:

All surface water samples will be collected directly into the sample container. Sample container type will be determined by whichever chemical analysis is performed on the sample. The following table describes which sample container is used with which analytical procedure.

Analytical Procedure	Sample Container
SVOCs (SW846/8270C)	1-liter amber jar unpreserved
Metals (SW-846/6000-7000 Series)	500 ml plastic container with preservative
PAHs (SW-846/8310)	1-liter amber jar unpreserved
Pesticides (SW-846/8081)	1-liter amber jar unpreserved
OP Pesticides (SW-846/8141)	1-liter amber jar unpreserved
Explosives (SW-846/8331)	1-liter amber jar unpreserved
Perchlorate (SW-846/8321)	250 ml plastic container unpreserved
Total Suspended Solids (EPA/160.2)	250 ml plastic container unpreserved

It is important to reiterate that the 40-ml glass vials with preservative will not be submerged into the water for sampling. A separate 1-liter amber container will be filled with sample water and then transferred to the 40-ml glass vials with preservative as to not lose the preservative within the 40-ml sample vial.

6 Materials:

- sample containers with lids;
- sample labels;
- dissolved oxygen meter and probe;
- pH meter and probe;
- specific conductance meter and probe;
- temperature probe;
- waterproof marking pens;
- coolers (with ice) for sample storage;
- sample data forms/clip board;
- decontamination supplies;
- camera and film/disks; and
- personal & safety gear;

7 Hazards & Precautions:

7.1 Field-collected surface water might contain potentially toxic/hazardous materials, and thus should be treated with caution to minimize exposure to workers. Waterproof clothing (waders/heavy rubber boots) and gloves are recommended.

7.2 The sample containers might contain preservatives, which might be harmful to sampling personnel. Extra care must be taken to prevent worker exposure to these preservatives and loss of the preservatives during sample collection.

7.3 The project Health and Safety Plan must be reviewed to identify further hazards, precautions and safety procedures.

8 Sample Preparation:

8.1 Sample locations may be adjusted on-site as deemed necessary by the location of riffles, pools, swallow areas, areas of low to no water, or other factors. A pre-sampling site inspection should be conducted to evaluate whether these procedures are feasible for sampling the desired locations.

8.2 Appropriate new sample containers must be obtained from the analytical laboratory or a commercial supplier. The analytical procedures must be reviewed to identify the proper sample container material, size, and preparation.

8.3 The Field Team Leader must read the Quality Assurance Project Plan before field sampling procedures are undertaken to understand how many, and what type of QA/QC samples are required.

8.4 All field team personnel must read the Health and Safety Plan prior to sampling to review applicable safety requirements.

9 Preparation of Apparatus:

9.1 All sampling containers will be pre-cleaned and delivered to the sampler without threat of contamination. During surface water sampling, if the sample container comes into contact with any surface other than the sample water or the samplers gloved hand, the sampler will discard the potentially contaminated container and use another sterilized container to retrieve the sample.

9.2 The field meters and probes should be calibrated and tested, according to the manufacturer's specifications.

10 Calibration & Standardization:

The field meters (pH, dissolved oxygen, and specific conductance) must be calibrated according to the manufacturer's manuals.

11 Procedure:

11.1 Identify the sample location from the sampling map.

11.2 Label all sample bottles for the specific sample location.

11.3 Collect ancillary field measurements (pH, dissolved oxygen, temperature, specific conductance) in an area immediately downstream of, or away from the sampling site.

11.4 Collect water samples. Submerge the water sample containers to collect water samples. Be certain to avoid turbidity caused by disturbance of the sediment surface; completely fill (no bubbles) the sample containers for the VOC and SVOC analyses; do not spill sample preservatives. Pack the water samples in the cooler with ice. Id the water body to be sampled is shallow, the sampling team should avoid disturbing the sediments with the sample container. If the sample container cannot be completely

/submerged into the water body, the sampling team should use a small sample container to collect the sample as to not disturb the underlying sediment. The sample water can then be transferred into the appropriate container for shipment to the labatory. For samples being submitted for dissolved metals analysis, a peristaltic pump, disposable Teflon tubing, and disposable 0.45 μ filters will be used in the field for collection. The sample team will place the disposable tubing into the water, the water will move through the peristaltic pump and disposable 0.45 μ filter, and be caught in the appropriate sample container to be prepared for shipment to the laboratory.

11.5 Mark the sampling site with a stake, buoy, flagging, etc. so the exact location can be surveyed.

11.6 Photograph sample location and marker stake.

11.7 Verify sample identifications on the Chain-of-Custody form.

11.8 Decontaminate the pH and specific conductance meter probes.

12 Calculations

Not Applicable

Applicable Forms

Surface Water Sampling field Data Sheet

Field Audit for Surface Water Sampling

Audit Finding Record

Photograph Log

Maintenance Log

Surface Water Sampling Field Data Sheet

Equipment Used:

Sample Type: **Grab** **Composite**

Project No.:	Location Description:		
Sampling Personnel:		GPS Personnel:	
Sample Date/Time (dd-mon-yy/military):		GPS Date/Time (dd-mon-yy/military):	
Polygon Name:			
Transect ID (if applicable):		Sample_ID (point):	
Sample Description		Sample Depth	
Field Descriptions & Observations:			
Sunny ☐	Partly Sunny ☐	Cloudy ☐	Raining ☐
Calm ☐	Slightly Windy ☐	Windy ☐	Gusting Winds ☐
Ambient Air Temperature (°C): _______________			
Specific conductance (μmhos)		Water temperature (°C)	
pH		Dissolved oxygen (mg/L)	

Water samples collected (check)			
	volatile organic compounds		TAL metals (6010B IC3 and GFAA)
	semi-volatile organic compounds		cyanide
	polynuclear aromatic hydrocarbons		mercury, pH, alkalinity, and TSS
	polychlorinated biphenyls		hardness
	pentachlorophenol by 8151		Other _____________________

Photo Date/Time:	Disk ID:	# of Photos already used:

Frame	Direction	Photo ID	Frame	Direction	Photo ID

Comments

Shaded cells must match attribute names used in GPS Data Dictionary.

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Barrington, Illinois 60010

Audit Checklist for Surface Water Sampling

Project Description	Field Team Leader
Project No.	Audit Date
Sampling personnel	Audit No.

Audit Question	S	U	N/A	comments
Were all personnel briefed on their assignment?	☐	☐	☐	
Did the crew have all the forms and maps, equipment and materials necessary to complete the assigned tasks?	☐	☐	☐	
Were the sampling locations correctly identified on the forms?	☐	☐	☐	
Were the field meters properly calibrated?	☐	☐	☐	
Were samples collected according to the procedure and all potential interferences addressed before sampling?	☐	☐	☐	
Was the depth of the sediment samples consistent?	☐	☐	☐	
Were sample locations properly marked for the survey crew?	☐	☐	☐	
Were the sampling equipment and meter probes properly cleaned between sample locations?	☐	☐	☐	
Were all sample containers properly labeled?	☐	☐	☐	
Were all sample containers properly filled (e.g. no head space)?	☐	☐	☐	
Were all samples properly packed for shipping?	☐	☐	☐	
packed in ice?	☐	☐	☐	
custody seals in appropriate places?	☐	☐	☐	
Did personnel adhere to the safety procedures?	☐	☐	☐	

Auditor Signature: ____________________

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Barrington, Illinois 60010

Audit Finding Report

Project No.	Task No.	Audit No.	Audit Date
Individual(s) contacted		Auditor Signature	
Requirements			
Findings			
Recommended Corrective Action			
Scheduled Response Date	Responsible for Corrective Action		
Corrective Action Taken			
Date	*Submitted by*	*Management Approval*	
Date Response Received		Response Acceptable? Yes No	
Reason for Rejection			
Verification			
Date Verified	Auditor Signature		

Photograph Log

Project Description		Field Team Leader	
Project No.	Task No.		Photos By
Date(s)		Location	
Film Type		Roll/Disk # of	

Frame	Subject/Sample ID	Frame	Subject/Sample ID
1		19	
2		20	
3		21	
4		22	
5		23	
6		24	
7		25	
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10		28	
11		29	
12		30	
13		31	
14		32	
15		33	
16		34	
17		35	
18		36	

Manufacturer:	**In-Service Date:**
Model No:	**Replacement Date:**
S/N:	
Contact Information:	
Location:	

Date	Service Type	Serviced by:	Notes:

Standard Operating Procedure for Decontaminating Sediment Sampling Equipment

1 Scope & Summary:

This standard operating procedure (SOP) outlines techniques for decontaminating sediment sampling equipment including wader boots and waders, where appropriate. This SOP describes the decontamination of equipment used to collect sediment either by using a small boat or by wading.

Decontamination consists of physically removing contaminants or changing their chemical nature to render them innocuous. Decontamination procedures appropriate to a site's hazards must be developed and implemented before anyone enters the site, and must continue throughout site operations.

2 Reference Documents:

ASTM (E1391-90) *Standard guide for collection, storage, characterization and manipulation of sediments for toxicological testing*. American Society for Testing and Materials, Annual Book of ASTM Standards. vol. 11.02, Philadelphia, PA.

Mudroch, A & S MacKnight (1994) *Bottom sediment sampling. In Handbook of Techniques for Aquatic Sediments Sampling*. Second Edition. A Mudroch & S. MacKnight (eds.) Lewis Publishers, Ann Arbor, MI pp. 29-96.

USEPA (1985) *Sediment sampling quality assurance user's guide*. EPA 600/4/85/048. U. S. Environmental Protection Agency, Environmental Monitoring and Support Lab., Las Vegas, NV 114 pp.

3 Significance and Use:

Decontamination of sediment sampling equipment must be preformed after each piece of equipment is used to avoid cross-contaminating future sediment samples. Once the sediment sampling equipment is decontaminated using the protocols outlined in this SOP, the equipment should be available for sampling without the threat of cross-contamination.

4 Potential Interferences:

4.1 Residual sediment might remain in sampling equipment and contaminate subsequent samples. To prevent contamination, all sampling equipment must be thoroughly decontaminated between sample locations.

4.2 The decontamination area must be established in a secure area where trespassers cannot come into contact with the decontamination area. Additionally, the decontamination area must be established in an area where decontaminated sampling equipment will not come into contact with airborne contaminants. Therefore, the decontamination area should not be established adjacent to highway/traffic areas, railroad right of ways, areas where industrial emissions are present (stacks, vent pipes, etc.).

4.3 Decontamination personnel must don shoulder-length gloves (or equivalent) prior to decontaminating equipment. Donning gloves provides a level of protection for sampling personnel and also decreases the likelihood of cross-contamination between the hands of the samplers and decontaminated sampling equipment.

5 Materials:

- Safety glasses;
- Fiberglass boat or “bass buddy”
- Shoulder-length gloves;
- Powder-free nitrile gloves;
- Toilet brushes;
- Garden sprayer;
- 3 plastic tubs (“kiddie pools”)
- Non-phosphate detergent;
- Potable water source;
- Distilled water;
- Garden hose;
- Laboratory-grade water;
- Paper towels;
- 55-gallon drums;
- Coolers for storage of equipment

6 Hazards & Precautions:

6.1 Field-collected sediments might contain potentially toxic materials or have hazardous characteristics (i.e., low pH) and thus should be treated with caution to minimize exposure to workers. While decontaminating equipment, safety glasses and gloves should be worn.

6.2 The project Health and Safety Plan must be reviewed to identify further hazards, precautions and safety procedures.

7 Preparation of Decontamination Area

7.1 Prior to sampling, an appropriate decontamination area should be selected. As described in Section 4.2 of this SOP, the decontamination area should be established in an area where there will be no cross-contamination from trespassers or airborne contaminants. The decontamination area should have a source of potable water and have enough space to support the sampling teams and associated field and decontamination equipment.

8 Procedure (non-boat equipment only)

8.1 Decontaminate the plastic tubs. The decontamination crew should don safety glasses and shoulder-length gloves for splash protection. Add non-phosphate detergent and potable water to each tub. Use a toilet brush (or equivalent) to scrub the tubs thoroughly. Once the cleaning process is complete, place the decontamination water in a 55-gallon drum for storage. Once the decontamination water has been transferred to the 55-gallon drum, rinse the tubs with distilled water using the garden sprayers. Conduct a final rinse with laboratory-grade water on one of the tubs only. The laboratory-grade water should be poured directly from the carboy provided by the laboratory on to the tub for the final rinse. Do not fill a garden sprayer with laboratory-grade water and use the sprayer to conduct the final rinse. The final rinse should come directly from the carboy provided by the laboratory. Once the tubs have been decontaminated, the sampling teams are ready to decontaminate the sediment sampling equipment.

8.2 Fill one tub with non-phosphate detergent and potable water. Place the used sampling equipment into the tub with the detergent and potable water. With safety glasses and shoulder-length gloves donned, the decontamination crew uses a toilet brush to thoroughly scrub the equipment. The scrubbing action should free all visible materials (mud, dirt, sheening, weathered product, etc.) from the equipment. Once the visible materials are removed, the equipment should continue to be scrubbed to remove any material that is not visible to the naked eye.

8.3 Once the field equipment has been thoroughly scrubbed, the equipment should be transferred to a second tub where it is rinsed with distilled water using a garden sprayer. The equipment should be rinsed so that, at a minimum, all soap from the scrubbing process is removed.

8.4 Once the field equipment has been rinsed with the distilled water, a final rinse should be conducted using laboratory-grade water. The laboratory-grade water should be poured directly from the carboy provided by the laboratory on to the sampling equipment for the final rinse. Do not fill a garden sprayer with laboratory-grade water and use the sprayer to conduct the final rinse. The final rinse should come directly from the carboy provided by the laboratory. The final rinse will be with the use of “organic free” water for organic analyses. Inorganic analyses can use laboratory grade water that is not specified as “organic free”.

8.5 Once the field equipment has been rinsed a final time with laboratory-grade water, the sampling equipment may be placed in the third tub that received the final rinse with laboratory-grade water as described in Section 8.1 of this SOP. The third tub is used for drying the decontaminated equipment.

8.6 Once the sampling equipment is decontaminated, the sampling crews should decontaminate their wader boots and waders. Each member of the sampling crew will step into the first tub that contains the detergent/water mixture. With the assistance of other crew member, thoroughly scrub the boots and waders of the crew member to remove all visible material. Once all visible material is removed, continue to scrub the boots and waders to remove material that is not visible to the naked eye. Once the scrubbing has concluded, the crew member is rinsed with distilled water using a garden sprayer while remaining the first tub. The sampling personnel do not step into the second tub to rinse.

8.7 Once the decontamination process is complete, the remaining water in the first and second tubs should be discarded into a 55-drum for storage.

8.8 The decontamination equipment (detergent, brushes, gloves, etc.) may now be stored in coolers until the next decontamination event.

8.9 Repeat Section 8.1 through Section 8.7 for the next decontamination event.

9 Procedure (boat only)

9.1 Lean the boat to one side so that the belly of the boat is exposed.

9.2 The decontamination team should don shoulder-length gloves and safety glasses for splash protection.

9.3 Fill one of the plastic tubs with non-phosphate detergent and potable water. Fill a garden sprayer with distilled water.

9.4 Using a toilet brush, scrub the belly of the boat with the detergent/water mixture. Thoroughly scrub the belly until no visible material is present. Continue to scrub to remove all material that is not visible to the naked eye.

9.5 Spray the belly of the boat with distilled water to rinse the belly free of soap. This will be the only rinse necessary for the boat.

9.6 No other portion of the boat requires decontamination as only the belly comes into contact with the surface water that lies above the sediments being sampled. The decontamination water will not be collected while decontaminating the boat. This water will be allowed to evaporate on the pavement. It is anticipated that the belly of the boat will not be grossly contaminated and will only come into contact with the surface water.

Applicable Forms

No forms are necessary for decontamination of sediment sampling equipment

Standard Operating Procedure for the Collection of Specific Conductance (SC) Data in Freshwater Ecosystems.

1 Scope & Summary

This standard operating procedure (SOP) outlines the procedures for collecting specific conductance (SC) data in the field from in freshwater ecosystems (surface water bodies) utilizing a variety of conductivity meters.

2 Reference Documents

USEPA (1983) Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati OH 430 pp.

APHA (1999) Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington D.C. pp 1325

3 Significance and Use

This SOP is applicable only to the measurement of conductivity in freshwater ecosystems (surface water bodies). The SOP is to be followed whenever conductivity measurements are made, in freshwater ecosystems (surface water bodies). While these data are scientifically defensible and can be used to aid in the decision-making process in the field, they may not withstand legal scrutiny in court proceedings.

4 Potential Interferences

4.1 Platinum electrodes can degrade and cause erratic results. When this happens, as evidenced by erratic results or flaking off of the platinum black, the electrode should be replatinized. NOTE: Some electrodes are manufactured so that they cannot be replatinized. If these probes begin producing erratic results, replacement of the probe may be the only option. Contact the manufacturer for technical assistance.

4.2 Coatings of oily material or particulate matter can impair the response of the conductivity cell. These coatings can usually be removed by gentle wiping or detergent washing, followed by rinsing with deionized water. An additional rinsing with ethanol or acetone may be necessary to remove any remaining film. If the cell has received a coating of lime or hydroxide from samples, the cell may be soaked in 10% acetic or hydrochloric acid solution. If contaminants cannot be removed by the above cleaning methods, concentrated acid (such as nitric or acetic) may be used sparingly. However, cleaning may cause a slight shift in the cell constant. The cell constant must be determined before additional measurements are made.

4.3 Significant errors may result if the effects of temperature are ignored. For best results, use a temperature compensated conductivity cell, a separate ATC probe, or manual temperature compensation with the actual sample temperature entered in the meter. If a temperature compensated conductivity cell is not available the temperature of the water sample should be maintained at 25°C.

4.4 The conductivity meter should be calibrated as directed by the instruction manual. If the meter is not properly calibrated prior to use, incorrect readings will be collected in the field.

Standard Operating Procedure for the Collection of Redox Potential (ORP) Data in Freshwater Ecosystems

1 Scope & Summary

This standard operating procedure (SOP) outlines the procedures for collecting redox potential (ORP) data in the field from in freshwater ecosystems (surface water bodies) samples utilizing a variety of ORP meters.

2 Reference Document

USGS (1998) Handbooks for Water-Resources Investigations, Book 9 Section A: National Field Manual for the Collection of Water-Quality Data. US Department of the Interior, US Geological Survey, Reston VA

3 Significance and Use

This SOP is applicable to the measurement of ORP in surface water. The SOP is to be followed whenever ORP measurements are made in freshwater ecosystems (surface water bodies). However, in contrast to other standard methods for ancillary chemistry, field measures of ORP are not considered routine. Field measures of ORP can show quantitative trends in redox, but not equilibrium values. As such, these data are scientifically defensible and can be used to aid in the decision-making process in the field, they may not withstand legal scrutiny in court proceedings.

4 Potential Interferences

4.1 Significant sample flow across the probe can cause erratic results due to the effects of excessive ion streaming. This can be remedied by a reduction in sample flow rate.

4.2 The electrode filling solution should be selected to best match the ionic strength of the sample solution to minimize junction potentials. The level of the filling solution should always be at least one inch above the level of the sample.

4.3 Exposure of the sample to air and/or excessive turbulence may significantly decrease the accuracy of the reading.

4.4 Organic mater, sulfide, and hydrogen sulfide may contaminate the electrode surface, salt bridge, internal electrolyte, and result in drift or erratic performance when reference electrodes are used.

4.5 Solutions containing chromium, uranium, vanadium, or titanium ions and other ions that are stronger reducing agents than hydrogen or platinum, may yield unstable readings when utilizing platinum single/combination probes.

4.6 If utilizing Zobell's solution, do not place probe into iron-rich waters directly after contact with Zobell's or an insoluble blue precipitate will coat the probe and cause erratic readings.

5 Apparatus and Materials

- millivolt (mV) meter or pH meter with millivolt reading capability and redox electrodes, either platinum, reference electrode, combination electrode, or a dedicated ORP meter.
- Electrode filling solution specified by the manufacturer of the electrode probe;
- Thermometer or ability to measure temperature;

- analysis container (ex. glass/plastic beakers);
- reagent-grade water
- Kimwipes

6 Hazards & Precautions

6.1 Samples might contain potentially toxic materials, and thus should be treated with caution to minimize exposure to workers. Gloves are recommended.

6.2 The project Health and Safety Plan must be reviewed to identify further hazards, precautions and safety procedures.

6.3 Some ORP calibration and electrode probe filling solutions may be toxic, utilize the Health and Safety Plan procedures for handling hazardous substances.

7 Electrode Preparation

7.1 See manufacturer's specifications for electrode preparation, storage, and maintenance.

8 Calibration and Standardization

8.1 Redox probes are calibrated by the manufacturer; therefore, field calibration is not necessary. However, the calibration of the probe can be verified using calibration solutions (@ 25°C) specified by the manufacture of the electrode probe or meter. If a verification of calibration is performed in the field, the results must be documented on the field ORP calibration forms and/or in the field logbook.

8.2 The following table summarizes the calibration and standardization information of the ORP meter:

QC Measures	Calibration Frequency	Acceptance Criteria	Correction Action	Decontamination Procedures
Field Duplicate, freq. of 10%	Not Applicable-Factory calibrated	Suspect data	Clean electrode and replace electrode solution; return to factory	Rinse thoroughly with DI water

9 Procedures for the Collection of Redox Potential Data

9.1 When collecting redox potential data, care should be taken to eliminate the exposure of the sample to air prior to measurement. If the sampling location does not allow for the immersion of the electrode probe into a constantly flowing sample stream, samples should be placed in clean, new, sample collection containers provided by the analytical laboratory providing the remainder of the matrix analysis. Sample collection procedures should be designed to minimize sample agitation, as well. However, Redox potential readings should be collected as the sample is slowly pumped through a closed system, such as a flow-through cell. If a closed system is not available, the accuracy of the data may be significantly reduced.

9.2 Ensure that the temperature of the sample has stabilized at 25°C.

9.3 Place the sample in a clean container (ex. glass/plastic beaker) using a sufficient volume to cover the sensing bulb at the base of the electrode probe. If field measurements are taken without using a magnetic stirring bar, the electrode may be immersed to an adequate depth and moved in a manner to ensure sufficient sample movement across the sensing bulb.

9.4 Immersion of the probe into the sample, make sure that sufficient sample flow is present during measurement (agitate sample or move probe). When the meter senses that the reading is stable, STABLE or READY will appear on the meter display. Record the measurement on the appropriate sample data form. If the meter does not provide a STABLE or READY display function, record the most stable reading reported.

9.5 Decontaminate the probe between samples by thoroughly rinsing the electrode with reagent water and remove residual water with a clean Kimwipe.

Applicable Forms

Field ORP Meter Calibration Sheet

Surface Water Sampling Field Data Sheet

Maintenance Log

Field ORP Meter Calibration Sheet

S/N of Instrument Used	Date	Time	Initials of Sampler	Calibration solution used	Meter Reading	Notes

Surface Water Sampling Field Data Sheet

Equipment Used:

Sample Type: **Grab** **Composite**

Project Description		Field Team Leader	
Project No.	Date	Time	
Sampling Personnel			
Sample ID			
Description of Sample Location & Observations			
Sunny ☐	Partly Sunny ☐	Cloudy ☐	Raining ☐
Calm ☐	Slightly Windy ☐	Windy ☐	Gusting Winds ☐
Ambient Air Temperature (°F):		Flow:	
Specific conductance (μmhos)		Water temperature (°C)	
pH		Dissolved oxygen (mg/L)	
Water samples collected (check)		Redox:	
	volatile organic compounds		volatile organic compounds
	semi-volatile organic compounds		semi-volatile organic compounds
	priority pollutant pesticides		polychlorinated biphenyls
	total organic carbon		Other ______________________
	particle size distribution		Other ______________________
Comments			

Maintenance Log

Manufacturer:	In-Service Date:
Model No:	Replacement Date:
S/N:	
Contact Information:	
Location:	

Date	Service Type	Serviced by:	Notes:

Standard Operating Procedure for the Collection of pH Data from Freshwater Ecosystems

1 Scope & Summary

This standard operating procedure (SOP) outlines the procedures for collecting pH data in the field from in freshwater ecosystems samples (surface water bodies). This SOP is to be utilized to collected pH data in freshwater ecosystems utilizing a variety of pH meters.

2 Reference Documents

USEPA (1983) Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati OH 430 pp.

APHA (1999) Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington D.C. 1325 pp.

3 Significance and Use

This SOP is applicable only to the measurement of pH in surface water bodies during the RI. While these data are scientifically defensible and can be used to aid in the decision-making process in the field, they may not withstand legal scrutiny in court proceedings.

4 Potential Interferences

4.1 Samples with very low or very high pH may give incorrect readings on the meter. For samples with a pH of > 10, the measured pH may be incorrectly low. This error may be minimized using a low sodium error electrode. For samples with a pH of < 1, the measured pH may be incorrectly high.

4.2 Coatings of oily material or particulate matter can impair electrode response. These coatings can usually be removed by gentle wiping or detergent washing, followed by rinsing with deionized water. An additional rinsing with a hydrochloric acid solution (1:10) may be necessary to remove any remaining film.

4.3 Temperature fluctuations will cause measurement errors by the instrument. This interference can be controlled with instruments having temperature compensation or by calibrating the electrode-instrument system at the temperature of the samples. However, temperature fluctuations may also cause a change of pH within the sample. This error is sample-dependent and cannot be controlled. Therefore, it should be noted by recording both the pH and the sample temperature at the time of analysis. When analyzing the sample, if possible, maintain the sample temperature at 25°C.

4.4 The pH meter should be calibrated as directed by the instruction manual. If the meter is not properly calibrated prior to use, incorrect readings will be collected in the field.

5 Apparatus and Materials

- pH meter;
- combination pH electrode;
- pH buffer solutions of 4.01, 7.00, and 10.01. NOTE: Buffer solutions should be refrigerated, if possible, and must be replaced after six months of use;
- thermometer and/or temperature sensor for automatic compensation;
- analysis container (ex. glass/plastic beakers);
- Kimwipes.

6 Hazards & Precautions

6.1 Samples might contain potentially toxic materials, and thus should be treated with caution to minimize exposure to workers. Gloves are recommended.

6.2 The project Health and Safety Plan must be reviewed to identify further hazards, precautions and safety procedures.

7 Electrode Preparation

When using a combination pH electrode, uncover the filling hole and add filling solution, if necessary. The filling solution must always be above the reference junction within the electrode and at least one-inch above the sample level when immersed. Place the electrode in the electrode holder and suspend in air for 15 minutes to thoroughly wet the reference junction. Once the junction is wet, do not allow the electrode to dry out. Prior to use, soak the electrode in storage solution or buffer solution with a pH of 7 for one hour.

8 Calibration & Standardization

The pH meter must be calibrated according to manufacturer specifications. The meter/electrode system will be calibrated using a minimum of two points (buffer solutions) that bracket the expected pH of the samples and are approximately three pH units or more apart. Thoroughly rinse the electrode with reagent water prior to measuring the pH of each buffer solution and following calibration procedures. All information regarding the calibration of the meter/electrode system (e.g., date, time, buffer solutions used, initials of field personnel, and final pH slope reading) must be documented on the field pH meter calibration sheet (see below).

A calibration check should be performed once for every 10 investigative readings collected (or 10%). To perform a calibration check, follow the specifications outlined in the instructional manual or as outlined below. Buffer 7 should be used at a minimum to assure that the meter is functioning properly in the field.

8.1 Immerse the electrode(s) into the sample solution (buffer 7). Agitate probe in buffer solution or stir moderately if possible. Note: Make sure the probe is in the pH buffer.

8.2 When the meter senses that the reading is stable, **STABLE** will appear under the measurement reading. The reading may be recorded at this time. If the meter does not have the capability of sensing when the meter has reached a stable reading, record the reading that the meter appears most stable.

8.3 The following table summarizes the calibration and standardization information of the pH meter:

QC Measures	Calibration Frequency	Acceptance Criteria	Correction Action	Decontamination Procedures

Field Duplicate, freq. of 10%	Beginning of each work day/freq. of 10% thereafter	Slope=90-102%	Re-calibrate/change buffers/replace KCL sol'n	Rinse thoroughly with DI water

9 Procedures for Measurement of Field pH Data in Aqueous Samples

9.1 When collecting pH data of in freshwater ecosystems samples, care should be taken to eliminate or minimize the exposure of the sample to air prior to measurement. Sample collection procedures should be designed to minimize sample agitation, as well. If the sampling location does not allow for the immersion of the cell into a constantly flowing sample stream, samples should be placed in clean, new, sample collection containers provided by the analytical laboratory providing the remainder of the matrix analysis. These containers should be free of any chemical preservation solutions and refrigerated until analysis. Field measurements of pH should be collected as soon as possible after sample collection.

9.2 Place the sample in a clean container (ex. glass/plastic beaker) using a sufficient volume to cover the sensing bulb at the base of the electrode probe. If field measurements are taken without using a magnetic stirring bar, the electrode may be immersed to an adequate depth and moved in a manner to ensure sufficient sample movement across the sensing bulb.

9.3 When the meter reading stabilizes senses that the reading is stable, STABLE or READY will appear on the meter display, and record the reading on the appropriate sample data sheet. If the meter does not provide a STABLE or READY display function, record the most stable reading reported.

9.4 Decontaminate the electrode probe between samples by thoroughly rinsing the electrode with reagent water. A detergent rinse may also be added to this procedure, if necessary. To remove residual water from electrode probe, wipe with a clean Kimwipe.

10 Calculations

If the meter/electrode system utilized does not allow for temperature compensation and a sample temperature differs by more than 2º C from the buffer solutions used during calibration, the measured pH value of the sample must be corrected. This temperature difference and adjustment to the measured pH value must be documented on the appropriate sample data form.

Applicable Forms

Field pH Meter Calibration Sheet

Surface Water Sampling Field Data Sheet

Maintenance Log

ENTRIX

Field pH Meter Calibration Sheet

S/N of Instrument Used	Date	Time	Initials of Sampler	Buffers Used	Slope Reading	Notes

Surface Water Sampling Field Data Sheet

Equipment Used:

Sample Type: **Grab** **Composite**

Project Description		Field Team Leader	
Project No.	Date	Time	
Sampling Personnel			
Sample ID			
Description of Sample Location & Observations			
Sunny ☐	Partly Sunny ☐	Cloudy ☐	Raining ☐
Calm ☐	Slightly Windy ☐	Windy ☐	Gusting Winds ☐
Ambient Air Temperature (°F):		Flow:	
Specific conductance (μmhos)		Water temperature (°C)	
pH		Dissolved oxygen (mg/L)	
Water samples collected (check)		Redox:	
	volatile organic compounds		volatile organic compounds
	semi-volatile organic compounds		semi-volatile organic compounds
	priority pollutant pesticides		polychlorinated biphenyls
	total organic carbon		Other ________________________
	particle size distribution		Other ________________________
Comments:			

MAINTENANCE LOG

Manufacturer:	In-Service Date:
Model No:	Replacement Date:

S/N:

Contact Information:

Location:

Date	Service Type	Serviced by:	Notes:

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 1

DECONTAMINATION OF DRILLING RIGS AND EQUIPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

This Site-Specific SOP presents decontamination procedures for drill rigs and heavy equipment/vehicles brought to the Refuge for use in soil and groundwater investigation activities and that have been used in areas and that have been used for soil and groundwater investigation activities. Decontamination of equipment and vehicles is required to prevent chemical cross-contamination.

Decontamination methods for heavy equipment include physical removal of dirt/debris and both physical/chemical means to clean surfaces.

PRIOR PLANNING AND PREPARATION

The following describes preparatory tasks prior to implementation of heavy equipment decontamination:

i) assembly and inventory of necessary cleaning equipment and supplies;
ii) review specific equipment cleaning protocols;
iii) check on acquisition, storage, and transportation of cleaning fluids;
iv) evaluate disposition of cleaning fluids upon completion of the work; and
v) set up of equipment decontamination area(s).

EQUIPMENT NEEDS

The following is a list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment, additional equipment may or may not be for any specific task.

- water and electrical source;
- pressure washer (supplied by drilling contractor);
- liquid IDW storage tanks;
- trash pumps and hoses;
- brushes if needed;
- non-phosphate detergent /soap; and
- PPE as specified in the HASP;

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 1

DECONTAMINATION OF DRILLING RIGS AND EQUIPMENT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

FIELD PROCEDURE

All equipment brought to the job site will be in good repair and free from oil, greases, hydraulic fluids, dirt, and debris. All downhole auguring, drilling, and sampling equipment should be sandblasted before use if painted, and/or if 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 will be performed by the contractor prior to arrival on Site. Upon arrival to the Site, the drilling rigs, support vehicles, and equipment will be inspected. Any equipment or supplies found to be unsuitable will be removed from the Site.

Upon first mobilization, decontamination prior to any drilling activity will entail thoroughly cleaning the rig, support vehicles, and all associated drilling and sampling equipment to remove oil, grease, mud, and other foreign matter. The entire drilling rig will be steam cleaned paying particular attention to any portion of the drill rig that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) to remove all rust, soil, and other material.

Auger Rigs

To prevent cross-contamination, following completion of drilling activities at each location, the portion of the rig that is over the intrusive location (the kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pull-downs, spindles, cathead, etc.) will be inspected to determine if this equipment shows signs of contact with potentially impacted soils and requires decontamination prior to moving to the next drilling location. Any portion of the rig, which comes in contact with contaminated materials, will be decontaminated.

If it is determined to be necessary, decontamination of the rig will be performed as follows:

i) brushing with non-phosphate detergent solution as necessary to remove foreign matter;
ii) washing with a high pressure hot wash using a non-phosphate detergent/potable water solution; and
iii) rinsing thoroughly with potable water.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 1

DECONTAMINATION OF DRILLING RIGS AND EQUIPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Before initiating drilling/sampling at each location (and at each subsequent location), downhole drilling equipment (augers, cutting bits, samplers, tools, and associated equipment) that have come in contact with soil will be decontaminated to prevent potential cross-contamination from the previous drilling activities.

Decontamination of downhole drilling equipment will be performed as described below:

i) brushing with non-phosphate detergent solution as necessary to remove foreign matter;
ii) washing with a high pressure hot wash using a non-phosphate detergent/potable water solution;
iii) rinsing thoroughly with potable water;
iv) the split spoon sampler and drive shoe will receive a final rinse with laboratory grade deionized (where inorganic analytes are of concern) and organic free water (where organic analytes are of concern).

Drilling equipment that is steam cleaned will be placed on racks or saw horses at least 2 feet above the floor of the decontamination pad. Augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids will be steam cleaned on the inside and brushed as necessary to remove material that cannot be removed by the steam cleaner. After final rinse, equipment will be removed from the decontamination pad and covered with clean, unused plastic sheeting. If stored overnight, the plastic sheeting will be secured to ensure that it stays in place.

The split spoon sampler and the drive shoe must be decontaminated between each use. Decontamination of the split spoon sampler can generally be performed in a series of 5-gallon plastic buckets as described below:

i) the first bucket contains the low-phosphate detergent solution for brushing and washing the equipment;
ii) the second bucket contains potable water for the first rinse;
iii) the third bucket contains potable water for the second rinse.
iv) the split spoon sampler and the drive shoe will receive a final rinse with laboratory grade deionized (where inorganic analytes are of concern) and organic free water (where organic analytes are of concern). If soil samples are

not being collected for chemical analysis the distilled water will be used for the final rinse.

The buckets will be contained in a small enclosure, such as a plastic "kiddie" pool, to act as secondary containment for the wash solution and rinse water.

Direct-Push Technology (DPT) Drilling Rigs and Equipment

To prevent cross-contamination, following completion of drilling activities at each location, the DPT rig will be inspected to determine if this equipment shows signs of contact with potentially impacted soils and requires decontamination prior to moving to the next drilling location. Any portion of the rig, which comes in contact with contaminated materials, will be decontaminated.

If it is determined to be necessary, decontamination of the DPT rig will be performed as follows:

i) brushing with non-phosphate detergent solution as necessary to remove foreign matter;
ii) washing with a high pressure hot wash using a non-phosphate detergent/potable water solution; and
iii) rinsing thoroughly with potable water.

Before initiating drilling/sampling at each location (and at each subsequent location), downhole drilling equipment (drill rods, samplers, tools, and associated equipment) that have come in contact with soil will be decontaminated to prevent potential cross-contamination from the previous drilling activities.

Decontamination of the DPT rig drive shoe and sampler (such as a Geoprobe®) equipment can generally be performed in a series of 5-gallon plastic buckets as described below:

i) the first bucket contains the low-phosphate detergent solution for brushing and washing the equipment;
ii) the second bucket contains potable water for the first rinse;

iii) the third bucket contains potable water for the second rinse.

iv) the DPT drive shoe and sampler will receive a final rinse with laboratory grade deionized (where inorganic analytes are of concern) and organic free water (where organic analytes are of concern).

The buckets will be contained in a small enclosure, such as a plastic "kiddie" pool, to act as secondary containment for the wash solution and rinse water.

The wash waters, soil debris, and spent protective wear must be properly segregated, containerized, labeled, and stored as described in Section 2.4 of the Field Sampling Plan (FSP).

Central Decontamination Facilities

The central decontamination pad will be constructed in area AUS-0A4W to accommodate cleaning of the drilling rigs and equipment upon arrival to the Refuge, prior to performing drilling activities, and when a drilling rig leaves the Refuge upon completion of the work. Additionally, the drilling rigs will be cleaned at the central decontamination pad after completion of work in a site, prior to proceeding to the next site. The central decontamination facility will have the appropriate equipment to thoroughly clean the drilling rigs and drilling equipment as described herein and to facilitate capture of cleaning fluids and sediments for proper management. The central decontamination will be constructed in a manner and will have sufficient capacity and pumping capability to prevent any overflow of fluids during decontamination activities. Figure 2.1 of the FSP depicts the general detail of the central equipment decontamination pad. Although not shown on Figure 2.1 plywood side shields will be used to contain over spray.

Temporary Decontamination Facilities

In order to more efficiently complete the fieldwork, in addition to a central decontamination pad at AUS-0A4W, a number of temporary equipment decontamination facilities will be constructed and operated at the various sites to clean downhole drilling equipment. Use of these temporary facilities will eliminate the need to travel potentially large distances from remote areas of the Refuge to the central decontamination facility to clean drilling equipment, tools, and sampling equipment.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 1

DECONTAMINATION OF DRILLING RIGS AND EQUIPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

The temporary decontamination facilities will likely consist of a large metal trough, steel drum, or a kiddy-pool, which will be used to contain fluids during decontamination.

The temporary decontamination facilities will have the appropriate equipment to thoroughly clean the drilling equipment, drilling tools, and sampling equipment and facilitate capture of cleaning fluids and sediments for proper management. In the event that a rig and or HAS need to be decontaminated at a specific AUS a temporary decontamination pad of sufficient size will be constructed. This temporary decontamination pad would be constructed of 6-mil polyethylene sheeting covered with plywood and have a berm sufficient to capture all of the decontamination fluids. Figure 2.2 of the FSP depicts the general detail of this type of a temporary equipment decontamination pad. Although not shown on Figure 2.2 plywood side shields will be used to contain over spray.

Decontamination fluids and sediment will be transferred to 55-gallon drums and staged at the temporary decontamination facilities. Drummed decontamination fluids and sediment will be moved to the central staging area upon completion of the investigative work in the area but at a frequency of no less than once per week. Drums will be labeled and handled in accordance with the procedures outlined in Section 2.4 of the FSP.

Conestoga-Rovers & Associates' (CRA's) Field Supervisor or Assistant Field Supervisor will inspect the central decontamination pad daily and prior to use and upon removal to confirm proper restoration of the decontamination area. CRA field supervisory personnel will inspect the temporary decontamination pad daily and prior to each use and upon removal to confirm proper restoration of the temporary decontamination areas. The inspections will be documented in the field logbook and will include comments on integrity of the decontamination pads, their state of repair, the need for repair, and any actions taken to address any immediate concerns.

Downhole UXO Equipment

In the identified potential UXO areas where intrusive investigative activities are to be performed, downhole UXO avoidance activities will be conducted. For subsurface soil borings (depths greater than 4 feet below grade) and monitoring well installations, downhole UXO avoidance activities will be required. Each 2-foot sampling interval will be cleared during borehole advancement beginning at 2 feet below ground surface. The

UXO personnel will clear each subsequent 2-foot sampling interval to a minimum depth of 10 feet using a downhole magnetometer.

Downhole UXO equipment will not be decontaminated between boreholes. The downhole UXO equipment is electrical and sensitive to water, therefore this equipment cannot be submerged into water. Instead the probe will be placed in a plastic bag/liner. The bag/liner will be changed between each use.

FOLLOWUP ACTIVITIES

The activities completed for each drill rig heavy equipment decontamination shall be documented in writing in the field book. Included in the field book shall be following information:

i) site location, date, time, weather;
ii) equipment use location;
iii) location where decontamination was performed;
iv) personnel performing decontamination;
v) decontamination procedures;
vi) sources of materials (solutions) used for decontamination;
vii) volume of decontamination fluids generated;
viii) location where decontamination fluids have been stored;
ix) individuals approving adequacy of decontamination; and
x) QA/QC sampling performed (if required).

The washwaters, soil debris, and spent protective wear must be properly segregated, containerized, and stored as described in Section 2.4 of the FSP.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 2

DECONTAMINATION OF SOIL AND GROUNDWATER FIELD EQUIPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

The following SOP presents decontamination procedures for field equipment used in the sampling of soil and groundwater, which are to undergo either physical or chemical analyses. This Site-specific SOP excludes procedures for decontamination of downhole drilling and DPT soil sampling tools (i.e., split spoon samplers, drilling rods, core barrels, Macrocore™ sampler, etc.) used to collect soil samples for chemical analysis, which are specifically addressed in Site-specific SOP 1 and for sampling equipment to be used to collect sediment samples for chemical analysis, which are specifically addressed in SOP 0025-004.

The purpose for decontamination of soil and groundwater field equipment is as follows:

- prevent cross-contamination of individual sampling sites and specific sampling locations;
- ensure that representative samples are collected for analysis;
- ensure proper operation of equipment and instrumentation; and
- reduce exposure hazards to workers involved in handling potentially contaminated materials.

PRIOR PLANNING AND PREPARATION

The following describes preparatory tasks prior to decontamination of soil and groundwater field equipment:

i) assembly and inventory of necessary cleaning equipment and supplies;
ii) review specific equipment cleaning protocols;
iii) check on acquisition, storage, and transportation of cleaning fluids;
iv) evaluate disposition of cleaning fluids upon completion of the work; and
v) set up of equipment decontamination area(s).

EQUIPMENT NEEDS

The following is a list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment, additional equipment may or may not be required for any specific task.

- distilled, deionized and organic free water;
- buckets or containers;
- liquid IDW storage containers;
- plastic sheeting and /or aluminum foil;
- brushes if needed;
- non-phosphate detergent /soap; and
- PPE as specified in the HASP;

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 2

DECONTAMINATION OF SOIL AND GROUNDWATER FIELD EQUIPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

FIELD PROCEDURE

The decontamination procedures for field equipment can be subdivided into two categories of cleaning as described below.

i) Those pieces of equipment that will come in direct contact with samples that are to be submitted for chemical analysis (i.e., pumps, stainless steel trowels, hand augers, etc.).
ii) Those pieces of equipment that are used to obtain field measurements (i.e., pH meters, temperature probes, water-level meters, etc.) or are used to collect samples that are not to be submitted for chemical analyses (i.e., split spoons that are use to collect geologic record samples).

The first category of equipment requires extensive, documented and defensible procedures. The second category requires less intensive cleaning procedures. Both categories of decontamination are described below.

i) Equipment Which Contacts Samples to be Chemically Analyzed

Non-disposable soil sampling equipment (trowels, spoons, hand shovels, scoops, etc.) will be decontaminated prior to field use and after each sample is collected to prevent cross-contamination between samples. Duplicate samples will be collected concurrently with original samples; therefore, sampling equipment will not be decontaminated before collection of the duplicate samples. Decontamination of equipment used for collecting samples for laboratory analyses will be performed as follows:

i) disassemble equipment as appropriate and wash with potable water and Alconox™ detergent (or equivalent non-phosphate detergent) using a brush, if necessary, to remove all visible foreign matter;
ii) rinse thoroughly with distilled water;
iii) rinse with laboratory grade deionized water (if inorganics are the suspect contaminant) or organic free water (if organics are the suspect contaminant);
iv) allow the equipment to air dry on a clean plastic sheet for as long as possible; and
v) wrap equipment in aluminum foil or clean plastic sheeting as necessary prior to transport to sampling location.

Following the final rinse, equipment will be visually inspected to verify that it is free of soil particles and other solid material that could contribute to possible sample cross-contamination.

Groundwater samples will be collected using a stainless steel bladder pump or stainless steel electric submersible pump. Decontamination of the bladder and electronic submersible pumps will be performed as follows:

i) disassemble pumps as necessary;
ii) use a brush, if necessary, to remove all visible foreign matter;
iii) place pump in a clean 2- to 4-inch diameter polyvinyl chloride (PVC) tube or a plastic tub containing a non-phosphate detergent solution;
iv) activate pump and allow water/detergent solution to circulate through pump and tubing for several minutes;
v) place sampling pump in a tub or clean PVC tube containing a minimum of 2 gallons of distilled water;
vi) activate pump and allow distilled water to circulate for several minutes then exit tub or tube through tubing;
vii) transport pump to next sampling location inside PVC tube; and
viii) prior to placing the pump into the next well place sampling pump in a clean PVC tube containing a minimum of 1 to 2 gallons of laboratory grade deionized water (if inorganics are the suspect contaminant) or organic free water (if organics are the suspect contaminant).
ix) activate pump and allow water to circulate for through the inside of the pump;

Note: If a pump such as the QED Sample Pro Portable Bladder Pump is used to sample a monitoring well, items iii) through vi) are eliminated. This type of pump is designed to be completely disassembled for decontamination and a new bladder is installed between sample locations. All parts of the bladder pump will be rinsed with laboratory grade deionized water (if inorganics are the suspect contaminant) or organic free water (if organics are the suspect contaminant) prior to reassembly.

Following the final rinse, equipment will be visually inspected to verify that it is free of soil particles and other solid material that could contribute to possible sample cross-contamination.

Groundwater screening samples will be collected using disposable equipment.

ii) Equipment Which Does Not Contact Samples Requiring Chemical Analysis

This category of cleaning includes sampling equipment used for collecting samples for physical analysis (i.e., inspection, grain-size distribution, etc.) and also those pieces of equipment that actually perform in field testing where no subsequent analyses of that portion of the samples is to be analyzed any further (i.e., pH meter, temperature probes, etc.).

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 2

DECONTAMINATION OF SOIL AND GROUNDWATER FIELD EQUIPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

For all field testing equipment, it is imperative that the cleaning procedures be completed in compliance with the manufacturer's specifications. Other cleaning methods may impact the instruments operating functions.

For all other sampling equipment that does not contact a sample requiring chemical analysis, rinsing with potable water is typically sufficient between uses. Following use at a site and prior to use at another site, the exterior surfaces of the sampling equipment will be cleaned/wiped with a non-phosphate detergent and potable water solution followed by a distilled water rinse to ensure that site contaminants are not transferred to another site.

Equipment placed into monitoring wells such as water level meters and pressure transducers will be cleaned with a non-phosphate detergent and potable water solution followed by a distilled water rinse and followed by an organic free water rinse.

Spent Decontamination Fluids and Solids

All used cleaning fluids and solids are to be handled in accordance with the procedures outlined in Section 2.4 of the FSP.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 3

BOREHOLE INSTALLATION AND SAMPLING (OVERBURDEN) CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

The following SOP presents the methods to be employed for the installation of boreholes (overburden). The basic soil description techniques are discussed; as well as the collection procedures for subsurface samples. Boreholes are typically installed to investigate geologic conditions for hydrogeologic and geotechnical evaluation; for the installation of monitoring wells and piezometers; for the collection of subsurface samples for chemical analysis; and for soil record retention purposes.

PRIOR PLANNING AND PREPARATION

The following activities must be undertaken prior to undertaking a borehole installation and subsurface soil sampling program.

i) Review the Work Plan, Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.

iii) Obtain a site plan and review any existing stratigraphic information. Determine the exact number and location of boreholes to be installed and the depths of samples for chemical analysis. Assemble sample containers if needed.

iv) Review with Field Supervisor and/or Site Safety Officer to determine whether UXO is a concern in the work area and assure the appropriate UXO clearance activities have been arranged pursuant to Section 2.3.2 of the FSP and Section 14 of the HASP.

v) Review with Field Supervisor whether utility clearance activities have been completed in the areas where subsurface investigations are to be conducted.

vi) Establish borehole locations in field using available landmark or by surveying methods if necessary.

vii) Evaluate access conditions with the Field Supervisor to determine whether any vegetation clearing is necessary to access investigative locations and coordinate required approvals of clearing activities with the FWS.

viii) Establish a water source for drilling and decontamination activities. Review procedures for handling and disposal of drill cuttings, wash waters, and spent decontamination fluids in Section 2.4 of the FSP.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 3

BORHOLE INSTALLATION AND SAMPLING (OVERBURDEN)
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

EQUIPMENT NEEDS

The following is a list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment; additional equipment may or may not be required for any specific task.

- equipment decontamination supplies;
- field book, field forms (hard copy or electronic);
- task specific documents and maps
- stainless steel bowls and trowels;
- air monitoring equipment:
- PPE as specified in the HASP;
- sample containers (sample container/preservative requirements are outlined in Tables 4-1 and 4-2. Of the QAPP);
- cooler and ice;
- stainless steel hand auger;
- camera; and
- re-sealable baggies;

PROCEDURE

LOCATION AND MARKING OF DRILL SITES/FINAL VISUAL CHECK

The proposed borehole locations marked on the site plan will be located in the field and staked. Once the final location for the proposed boring has been selected and utility and UXO clearances are complete, one last visual check of the immediate area should be performed before drilling proceeds. This last visual check should confirm the locations of any adjacent utilities (subsurface or overhead) and verification of adequate clearance. If gravity sewers or conduits exist in the area, any access manholes or chambers should be opened and the conduit/sewer alignments confirmed, if possible.

If it is necessary to relocate any proposed borehole due to terrain, utilities, access, etc., the Field Supervisor must be notified and an alternate location will be selected.

EQUIPMENT DECONTAMINATION FOR ENVIRONMENTAL SITES

Prior to use and between each borehole location follow the equipment decontamination procedures outlined in SOP 1 and SOP 2.

DIRECT-PUSH TECHNOLOGY (DPT)

Soil samples will be collected and piezometers and temporary wells will be installed using DPT, such as a Geoprobe® rig. To the extent possible, small and highly mobile

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 3

BORDEHOLE INSTALLATION AND SAMPLING (OVERBURDEN)
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

DPT drill rigs (i.e., small track-mounted ATV rigs) are preferred to expedite sample collection activities, maximize ability to access remote locations, minimize disruption to the local environment and habitat, and minimize the volume of IDW generated during the investigation. If subsurface obstructions prevent the use of a DPT drill rig, a drilling rig equipped with hollow stem augers (HSA) may be used.

In areas where UXO avoidance is necessary, personnel and equipment will stay on the pathways marked as described in Section 2.3.2 of this FSP. If the cleared pathways are not evident, personnel will notify the Field Supervisor and Site-Safety Officer and avoid the area until appropriate markings are replaced. Downhole UXO avoidance will also be required in these areas. Downhole UXO avoidance will be performed as described in Section 2.3.2.3 of the FSP. UXO avoidance activities will be discussed during daily health and safety briefings.

The DPT sampler will be equipped with a 4-foot long MacroCore™ or similar soil sampling device such that a sufficient volume of soil is obtained for sample collection purposes. The MacroCore™ soil sampling tool will be fitted with clean acetate liners prior to advancement to the target depth. Acetate liners will be discarded and managed as IDW following use.

DPT soil samples will be collected using the following procedure:

i) A new pair of disposable nitrile gloves will be donned for handling each sample.

ii) Prior to use at each sampling location, the rig and downhole sampling equipment will be decontaminated in accordance with SOP 1.

iii) The DPT sampler, equipped with an acetate liner, will be advanced to the top of the target interval. The piston head on the MacroCore™ sampler will then be released and the sampler will be driven through the target depth interval to obtain the soil sample. At locations where downhole UXO avoidance is required, the sampler will be advanced in 2-foot intervals, the sampler will be removed from the borehole, and a UXO check will be performed using procedure described in Section 2.3.2.3.

iv) The soil sample will be retrieved by pulling the rod string and sampler from the probe hole and removing the soil filled liner from the sample tube. The acetate liner will be cut into two equivalent 2-foot lengths. Each interval will be slit lengthwise to expose the full length of the soil sample.

v) The soil sample(s) selected for volatile organic compound (VOC) analysis will be collected from the selected sample interval in accordance with USEPA SW-846 Method 5035 (using Encore™ or similar soil piston samplers). Samples will be collected from each length of sample identified in item iv) above. Three Encore samplers will be cored into each length of soil sample in close proximity to one another near the center of each 2-foot interval to recover a total of approximately 15 grams of soil. When a sample is collected for VOC analysis one additional 2- or 4-ounce jar per sample depth interval will also be collected and sent to the laboratory for determination of percent moisture. The recovered soil samples will be immediately labeled and placed into a cooler containing ice pending shipment to the project laboratory for analysis.

vi) Following completion of v) above, a representative aliquot of each length of soil sample from each 2-foot interval will be placed in a re-sealable plastic bag for headspace monitoring. The bag will be sealed and agitated, if necessary, to break up clumps of soil.

vii) For non-VOC analysis sample(s), a representative aliquot of each length of soil sample from the target depth interval will be transferred into a clean stainless steel bowl and thoroughly homogenized using a stainless steel mixing utensil by vigorously stirring and turning over the soil sample and breaking up the clumps. The sample will then be split among the laboratory-supplied containers, labeled, and placed into a cooler containing ice.

viii) After approximately 5 minutes, a headspace reading will be obtained from the headspace sample by inserting the tip of the photoionization detector (PID) into the bag and recording the highest headspace reading. The PID reading will be recorded on the Sample Collection Field Sheet and on the Overburden Stratigraphic Log form.

Note: If visual signs of contamination or elevated PID head-space monitoring are encountered during borehole advancement a grab sample maybe collected from this interval.

Subsurface soil samples will be logged by a qualified geologist, engineer, or technician in accordance with the Unified Soil Classification System (USCS) and the information written on the Overburden Stratigraphic Log forms. Headspace readings obtained during borehole advancement also will be recorded on the Overburden Stratigraphic Log forms.

Boreholes will be closed by filling the borehole from the base to the ground surface with a cement bentonite grout. Following a period of at least 24-hours, the abandoned soil boring will be checked for settlement and if needed filled with granular bentonite. The top 6 inches of borehole will be capped with asphalt or concrete patching material or native soil as appropriate to match the existing surface.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 3

BORHOLE INSTALLATION AND SAMPLING (OVERBURDEN) CRAB ORCHARD NATIONAL WILDLIFE REFUGE

ROTARY DRILLING RIGS

Rotary drilling rigs equipped with HSA will be required to install groundwater monitoring wells and possibly to collect soil samples. Soil samples will be collected using a rotary drilling rig equipped using a 2-foot long split-spoon sampler constructed with a stainless steel-lined barrel or, where soil samples will be collected for geotechnical analysis, Shelby tubes. Due to the difficulty associated with maneuvering the larger rotary drilling rigs back and forth over a borehole, in areas where monitoring wells are to be installed in UXO avoidance areas (see Section 2.3.2.1), downhole UXO avoidance and soil sampling in the vadose zone may be completed first using a DPT rig. Surface and downhole UXO avoidance will be performed consistent with Sections 2.3.2.2 and 2.3.2.3 of this FSP and vadose zone soil samples for stratigraphic description and laboratory analysis will be performed consistent with Section 3.2.1 of this FSP.

Once the surface and downhole UXO avoidance activities are completed, the rotary drilling rig will be maneuvered into place over the cleared location for the purpose of installing a groundwater monitoring well.

Although not intended as the primary mode for the collection of soil samples for chemical analysis, rotary drill rigs may also be used to collect soil samples if borehole advancement by DPT fails and for convenience/rig availability purposes.

If during the RI potable water is added to a borehole to facilitate the installation of a monitoring well a sample of the potable water source will be collected and analyzed for the same parameters for which the monitoring well is to be sampled.

Rotary drill rigs will be used to advance boreholes for installing monitoring wells. During the advancement of these boreholes soil samples will be collected for visual observation and logging purposes. The stratigraphic information collected will be used to determine the depth at which to set the screen interval and to better define the stratigraphic conditions. Soil samples are not being collected for chemical analysis at most of the proposed monitoring well locations and at these locations items vi and viii of the following procedure would be omitted.

Soil samples will be collected with the rotary drill rig using the following procedure:

i) A new pair of disposable nitrile gloves will be donned for handling each sample.

ii) Prior to use at each sampling location, all sampling equipment will be decontaminated in accordance with the methods specified in SOP 1.

iii) A 2-foot long stainless-steel lined split spoon sampler or Shelby tube device will be advanced through the designated sampling interval in accordance with ASTM D1586-84 or ASTM D1587-83, respectively. *(Note Shelby tube samplers will only be used for collection of geotechincal soil samples)*

iv) The split-spoon sample or Shelby tube will be retrieved by removing the drill rods and sampler from the borehole.

vi) The soil sample(s) selected for VOC analysis will be collected from the selected 2-foot interval in accordance with USEPA SW-846 Method 5035 using Encore samplers. Three Encore samplers will be cored into the soil in close proximity to one another near the center of each 2-foot interval to recover a total of approximately 15 grams of soil. When a sample is collected for VOC analysis, one 2- or 4-ounce jar per sample depth will also be collected and sent to the laboratory for determination of percent moisture. The recovered soil samples will be immediately labeled and placed into a cooler containing ice pending shipment to the project laboratory for analysis ***(this item is only applicable when the soil sample is being retained for chemical analysis).***

vii) Following completion of v) above, a representative aliquot of the soil sample will be placed in a resealable bag for headspace monitoring. The bag will be sealed and agitated, if necessary, to break up clumps of soil.

viii) For non-VOC analysis sample(s), the soil sample from the target depth interval will be transferred into a clean stainless steel bowl and thoroughly homogenized using a stainless steel mixing utensil by vigorously stirring and turning over the soil sample and breaking up the clumps. The sample will then be split among the laboratory-supplied containers, labeled, and placed into a cooler containing ice ***(this item is only applicable when the soil sample is being retained for chemical analysis).***.

ix) After approximately 5 minutes, a headspace reading will be obtained from the headspace sample by inserting the tip of the PID into the bag and recording the highest headspace reading. The PID reading will be recorded on the Sample Collection Field Sheet and on the Overburden Stratigraphic Log form.

Note: If visual signs of contamination or elevated PID head-space monitoring are encountered during borehole advancement a grab sample maybe collected from this interval.

Subsurface soil samples will be logged by a qualified geologist, engineer, or technician in accordance with the USCS and the information written on the Overburden

Stratigraphic Log forms. Headspace readings obtained during borehole advancement also will be recorded on the Overburden Stratigraphic Log forms.

In the event a HSA advanced borehole requires closure, the borehole will be filled from the base to the ground surface with a cement bentonite grout mixture. The grout will be installed using a tremie pipe placed near the base of the borehole. The tremie pipe will be withdrawn as the borehole is filled with grout in a manner that minimizes the potential for bridging within the borehole annulus. Following a period of at least 24-hours, the abandoned soil boring will be checked for settlement and if needed filled with granular bentonite. The top 6 inches of borehole will be capped with asphalt or concrete patching material or native soil as appropriate to match the existing surface.

OTHER PROCEDURES

Standard Penetration Testing (SPT) Sampling and Testing Procedure

This method is used to obtain representative samples of subsurface soil materials and to determine a measure of the in situ relative density of the subsurface soils. The test methods described below must be followed to obtain accurate SPT values.

SPT sampling is performed by using a split barrel sampler in accordance with ASTM D1586. The split barrel sampler, or split-spoon, consists of an 18- or 24-inch long, 2-inch outside diameter tube, which comes apart length wise into two halves.

Once the borehole is advanced to the target depth and the borehole cleaned of cuttings, representative soil samples are collected in the following manner:

- the split-spoon sampler should be inspected to ensure it is properly cleaned and decontaminated. The driving shoe (tip) should be relatively sharp and free of severe dents and distortions;
- the cleaned split-spoon sampler is attached to the drill rods and lowered into the borehole. Do not allow the sampler to drop onto the soil;
- after the sampler has been lowered to the bottom of the hole, it is given a single blow to seat it and make sure that it is in undisturbed soil. If there still appears to be excessive cuttings in the bottom of the borehole, remove the sampler from the borehole and remove the cuttings; and
- mark the drill rods in three or four successive 6-inch increments, depending on sampler length, so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-inch increment.

The sampler is then driven continuously for either 18 or 24 inches by use of a 140-pound hammer. The hammer may be lifted and dropped by either the cathead and rope method, or by using a trip, automatic, or semi-automatic drop system. The hammer should free-fall a distance of 30 inches (±1 inches) per blow. To ensure a free-falling hammer, no more than 2 1/4 turns of the rope may be wound around the cathead (see ASTM D1586). The number of blows applied in each 6-inch increment is counted until one of the following occurs:

- a total of 50 blows have been applied during any one of the 6-inch increments described above;
- a total of 100 blows have been applied;
- there is no advancement of the sampler during the application of ten successive blows of the hammer (i.e., the spoon is "bouncing" on a stone or bedrock); or
- the sampler has advanced the complete 18 or 24 inches without the limiting blow counts occurring as described above.

In some cases where the limiting number of blow counts has been exceeded, the geologist may direct the driller to attempt to drive the sampler more if collection of a greater sample length is essential.

On the field form, record the number of blows required to drive each 6-inch increment of penetration. The first 6 inches is considered to be a seating drive. The sum of the number of blows required for the second and third 6 inches of penetration is termed the "standard penetration resistance" or the "N-value".

The sampler is then removed from the borehole and unthreaded from the drill rods. The open shoe (cutting end) and head of the sampler are partially unthreaded by the drill crew and the sampler is transferred to the geologist/engineer work surface.

The open shoe and head are removed by hand, and the sampler is tapped so that the tube separates.

Measure and record the length of sample recovered making sure to discount any sloughed material that is present on top of the sample core.

Thin-Walled Samplers (Shelby Tubes)

Thin-walled samplers such as Shelby Tubes are used to collect relatively undisturbed samples (as compared to split-spoon samples) of soft to stiff clayey soils. The Shelby Tube has an outside diameter of 2 or 3 inches and is 3 feet long. These undisturbed samples are used for certain laboratory tests of structural properties (consolidation, hydraulic conductivity, shear strength) or other tests that might be influenced by sample disturbance. Procedures for conducting thin-walled tube sampling are provided in ASTM D1587, and are briefly described below.

- the soil deposit being sampled must be cohesive in nature, and relatively free of gravel, and cobble materials, as contact with these materials will damage the sampler;
- clean out the borehole to the sampling elevation using whatever method is preferred that will ensure the material to be sampled is not disturbed. If groundwater is encountered, maintain the liquid level in the borehole at or above groundwater level during the sampling operation;
- bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted. Remove loose material from the center of a casing or hollow-stem auger as carefully as possible to avoid disturbance of the material to be sampled;
- place the sample tube so that its bottom rests on the bottom of the hole. Advance the sampler into the formation without rotation by a continuous and relatively rapid motion; usually hydraulic pressure is applied to the top of the drill rods;
- determine the length of advance by the resistance and condition of the formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays;
- in no case should the length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3 inches for cuttings.
- the tube may be rotated to shear the bottom of the sample 2 to 3 minutes after pressing in, and prior to retrieval to ensure the sample does not slide out of the tube. Lift the weight of the rods off of the tube prior to rotating.
- withdraw the sampler from the formation as carefully as possible in order to minimize disturbance of the sample;
- package and transport the sample.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 3

BORFHOLE INSTALLATION AND SAMPLING (OVERBURDEN)
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Soil Descriptions

The criteria and procedures for identifying and describing soil include:

i) Standard field identification method based on visual examination and manual tests.

ii) A standard method of describing the soil by name and group symbol.

iii) Verifying field description through inspection of representative soil samples by the person responsible for interpretation of subsurface conditions at the site.

iv) Confirming descriptive information by laboratory determination of selected soil characteristics for representative soil samples.

v) Factual stratigraphic logs confirmed by the person responsible for interpreting the subsurface conditions.

The stratigraphic log is a factual description of the soil at the borehole location and is relied upon to interpret the soil characteristics, and their influence and significance in the subsurface environment. The accuracy of the stratigraphic log is to be verified by the person responsible for interpreting subsurface conditions. An accurate description of the soil stratigraphy is essential for a reasonable understanding of the subsurface conditions. Confirmation of the field description by examination of representative soil samples by the project geologist, hydrogeologist, or geotechnical engineer (whenever practicable) is recommended.

The description for natural undisturbed soil is recorded on the Stratigraphy Log. Descriptions are completed in the following order:

- Unified Soil Classification System (USCS) group symbol(s) (e.g., SM) of primary soil components or dual and borderline symbols;
- name and adjective description of primary, secondary, and minor grain size components;
- relative density (for non-cohesive soil) or consistency (for cohesive soil);
- gradation and soil structure (for non-cohesive soil) or structure and plasticity (for cohesive soil);
- color;
- moisture condition; and
- other physical observations such as presence of stains or odors.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 3

BORHOLE INSTALLATION AND SAMPLING (OVERBURDEN)
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Note: *When describing vegetative matter presence in the soil column, do not use the term "organic" as this often leads to confusion with regards with organic chemical (i.e., NAPL) presence.*

The description of fill soil is similar to that of natural undisturbed soil except that it is identified as fill and not classified by USCS group, relative density, or consistency (i.e., SP/GP-Sand and Gravel (Fill)).

It is necessary to identify and group soil samples consistently to determine the subsurface pattern or changes and non-conformities in soil stratigraphy in the field at the time of drilling. The stratigraphy in each borehole during drilling is to be compared to the stratigraphy found at the previously completed boreholes to ensure that pattern or changes in soil stratigraphy are noted and that consistent terminology is used.

Visual examination, physical observations and manual tests (adapted from ASTM D2488, visual-manual procedures) are used to classify and group soil samples in the field and are summarized in this subsection. ASTM D2488 should be reviewed for detailed explanations of the procedures. Visual-manual procedures used for soil identification and classification include:

- visual determination of grain size, soil gradation, and percentage fines;
- dry strength, dilatancy, toughness, and plasticity (thread or ribbon test) tests for identification of inorganic fine grained soil (e.g., CL, CH, ML, or MH); and
- soil compressive strength and consistency estimates based on thumb indent and pocket penetrometer (preferred) methods.

The three main soil divisions are: coarse grained soil (e.g., sand and gravel), fine grained soil (e.g., silt and clay), and soil with high natural organic matter content (e.g., peat and marl).

Coarse Grained Soil

The USCS group symbols for coarse grained soil are primarily based on grain or particle size, grain size distribution (gradation), and percent fines (silt and clay content).

Coarse grained soil is made up of more than 50 percent, by weight, sand size, or larger (75 µm diameter, No. 200 sieve size or larger).

Descriptions for grain size distribution of soil include; poorly graded (i.e., soil having a uniform grain size, SP and GP) and well graded (i.e., poorly sorted; having wide range of particle sizes with substantial intermediate sizes, SW and GW).

Coarse grained soils are further classified based on the percentage of silt and clay they contain (fines content). Coarse grained soils containing greater than 12 percent fines are commonly described as dirty. This description arises from the soil particles that adhere when the soil is rubbed between the hands or adhere to the sides of the jar after shaking or rolling the soil in the jar. The jar shake test which results in segregation of the sand and gravel particles is also used as a visual aid in determining gravel and sand percentages.

Examples of the group symbol, name, and adjectives used to describe the primary, secondary, and minor components of soil are; GW - Sandy Gravel (e.g., 70 percent gravel and 30 percent sand) or Sandy Gravel trace silt (less than 10 percent silt), and SP - Sand, uniform.

Relative density is an important parameter in establishing the engineering properties and behavior of coarse grained soil. Relative density of non-cohesive (granular) soil is determined from standard penetration test (SPT) blow counts (N values) (after ASTM Method D1586).

The SPT gives a reliable indication of relative density in sand and fine gravel. N values in coarse grained soil are influenced by a number of factors that can result in overestimates of relative density (e.g., in coarse gravel and dilatent silty fine sand) and can be conservative and underestimate the relative density (e.g., sand below the groundwater table and uniform coarse sand). These effects will be assessed by the project geotechnical engineer, if required, and need not be taken into account by field personnel.

Other dynamic methods, such as modified SPT and cone penetration tests, are used on occasion to supplement or replace the SPT method for certain site-specific conditions. The details of all modifications to the SPT or substitute methods should be recorded as they are required to interpret test results and correlate to relative density.

Fine Grained Soil

A soil is fine grained if it is made up of half or more of clay and silt (i.e., fines greater than 50 percent by weight passing the 75 µm (No. 200) sieve size). A description of visual-manual field methods and criteria that are used to further characterize and group fine grained soil (e.g., CL, CH, ML, or MH) including dry strength, dilatancy, toughness, and plasticity (thread or ribbon test) follows.

CRITERIA FOR DESCRIBING DRY STRENGTH

Description	*Criteria*
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen crumbles into powder with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

CRITERIA FOR DESCRIBING DILATANCY

Description	*Criteria*
None	No visible change in small wetted specimen when rapidly shaken in palm of hand.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing or stretching.

CRITERIA FOR DESCRIBING TOUGHNESS

Description	*Criteria*
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

CRITERIA FOR DESCRIBING PLASTICITY

Description	*Criteria*
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.

Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

RECORDED INFORMATION

During the advancement of the boreholes the following information will be recorded on the stratigraphic log or in the field book:

i. depth interval of each sample collected, classified, and/or retained;
ii. length of sampled interval, length of sample recovery, and the sampler type and size (diameter and length).
iii. blow counts, hammer type and weight, and length of hammer fall for driven samplers.
iv. For thin wall samplers, whether the sampler was pushed or driven and the pressure/blow count per drive. Blow counts should be recorded in 0.5 ft increments when standard penetration (ASTM D 1586) samples are used.
v. If drilling fluid is used, a record should be maintained of fluid losses and/or gains and the interval over which they occur. Adjustment should be made for fluid losses due to spillage and intentional wasting (e.g. recirculation tank cleaning) to more closely estimate the amount of fluid lost to the subsurface environment.
vi. drilling fluid pressures typically used during all drilling operations.
vii. significant color changes in the drilling fluid return even when intact soil samples or rock core are being obtained.
viii. Headspace PID reading, if taken. Each notation should include interval sampled and reading.
ix. Borehole advancement method and whether additives were used in the process.

FOLLOWUP ACTIVITIES

The following activities should be completed at the end of each day.

i) prior to leaving a work area make sure equipment and supplies are secure and the work area is cleaned up and secure,
ii) ensure field book and field forms have been updated and are complete,
iii) ensure soil sample locates have been re staked,
iv) allow sufficient time to package, log and ship samples.
v) ensure collected field data is properly logged and filed.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 4

SURFACE SOIL SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

This SOP focuses on ways to obtain surficial soil samples for chemical analyses. The primary goal of surface soil sampling is to collect representative samples for examination and chemical analysis (if required).

PRIOR PLANNING AND PREPARATION

The following activities must be undertaken prior to undertaking a borehole installation and surface soil sampling program.

i) Review the Work Plan, Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.
ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.
iii) Obtain a site plan and review any existing stratigraphic information. Determine the exact number and location of surface soil samples for chemical analysis. Assemble sample containers if needed.
iv) Review with Field Supervisor and/or Site Safety Officer to determine whether UXO is a concern in the work area and assure the appropriate UXO clearance activities have been arranged pursuant to Section 2.3.2 of the FSP and Section 14 of the HASP.
v) Establish sampling locations in field using available landmark or by surveying methods if necessary.
vi) Evaluate access conditions with the Field Supervisor to determine whether any vegetation clearing is necessary to access investigative locations and coordinate required approvals of clearing activities with the FWS.
vii) Establish a water source for decontamination activities. Review procedures for handling and disposal of wash waters, and spent decontamination fluids in Section 2.4 of the FSP.

EQUIPMENT NEEDS

The following is a list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment; additional equipment may or may not be required for any specific task.

- equipment decontamination supplies;
- field book, field forms (hard copy or electronic);
- stainless steel bowls and trowels;
- air monitoring equipment;
- PPE as specified in the HASP;

- sample containers (sample container/preservative requirements are outlined in Tables 4-1 and 4-2. Of the QAPP);
- cooler and ice;
- stainless steel hand auger;
- camera; and
- re-sealable baggies;

PROCEDURE

General Procedures

At locations where surface soil sampling activity is concurrent with subsurface borings, soil samples will be collected from the 0- to 6-inch and the 6- to 24-inch depth intervals using the procedures detailed in SOP 3.

The preferred method to collect surficial soil samples will be to use a DPT rig or rotary drill rig to collect the samples following the Site-specific protocols outlined in Section 3.2.1 and SOP-3, except that headspace reading will not be obtained from the 0- to 6-inch or the 6- to 24-inch depth intervals due to the limited volume of soil available. In addition, at locations where surface soil sampling activity is concurrent with subsurface borings, soil samples will be collected from the 0- to 6-inch and the 6- to 24-inch depth intervals using the procedures detailed in SOP 3, as applicable, except that headspace reading will not be obtained from the 0- to 6-inch or the 6- to 24-inch depth intervals due to the limited volume of soil available. In general, soil will be collected from below the thatch zone and excessive organic matter (roots, plant debris) will be removed from the soil sample.

However, at remote locations inaccessible by DPT or drill rig, the following surface soil sampling procedures may also be used:

i) A new pair of disposable nitrile gloves (or equivalent) will be donned for each sample.

ii) A precleaned hand auger or stainless steel hand shovel will be used to obtain a soil sample from the 0 to 6-inch depth interval. The soil sample from the 0 to 6-inch interval will be placed in a precleaned stainless steel bowl and tasks v) through vi) completed prior to performing task iii).

iii) Following completion of soil sample collection activity for the 0 to 6-inch depth interval, the hand auger will be decontaminated as described in SOP 2, the hand auger will then be advanced through the 6 to 24-inch depth interval and the soil will be placed in a separate precleaned stainless steel bowl. As hand augers generally retrieve soil in 6-inch intervals, the hand auger will need to be advanced through three 6-inch intervals to obtain the 6 to 24-inch soil sample. The aliquots of soil from each 6-inch interval will be placed in a stainless steel bowl until the entire length is obtained. The sampler will complete this activity in the shortest reasonable period of time without delay between 6-inch intervals. Once the sample from the entire 6 to 24-inch depth interval is obtained, tasks iv) through v) will be completed.

iv) The soil sample(s) selected for VOC analysis will be collected in accordance with USEPA SW-846 Method 5035 using Encore or similar piston-type samplers. The Encore or similar piston-type samplers will be pushed into the soil within the pre-cleaned stainless steel bowl forcing the soil up and into the sampler (This is the same general procedure as used to collect soil samples from split spoon and DPT samplers). Three Encore samplers will be cored into the soil in the 0- to 6-inch and three Encore samplers will be cored into the soil in 6- to 24-inch depth intervals. A total of approximately 15 grams of soil will be recovered from each interval. When a sample is collected for VOC analysis, one 2- or 4-ounce jar per sample depth will also be collected and sent to the laboratory for determination of percent moisture. The separate recovered soil samples will be immediately labeled and placed into a cooler containing ice.

v) For non-VOC analysis a pre-cleaned stainless steel spoon, trowel, or hand shovel will be used to obtain the soil samples from the 0- to 6-inch depth interval. A sufficient volume of soil to fill sample containers will be placed into a clean stainless steel bowl and thoroughly homogenized by vigorously stirring, turning over the soil, and breaking up the clumps using a stainless steel mixing utensil. The sample will then be split among the laboratory-supplied containers, labeled, and placed into a cooler containing ice.

Soil sampling techniques are dependent upon the sample interval of interest, the type of soil material to be sampled, and the requirements for handling the sample after retrieval. Any surficial debris (i.e., grass cover) should be removed from the area where the sample is to be collected using a separate precleaned device.

Generally it is not advisable to collect samples containing excessive amounts of large particles such as gravel. Gravel presents difficulties for the laboratory in terms of sample preparation and may not be truly representative of contaminant concentrations in nearby soil.

All conditions at the time of sample collection should be properly documented in the field log book. This should include a thorough description of the sample characteristics, including grain size, color, and general appearance, as well as date/time of sampling and labeling information. The location of the sampling point should be described in the field log.

FOLLOWUP ACTIVITIES

The following activities should be completed at the end of each day.

i) prior to leaving a work area, make sure equipment and supplies are secure and the work area is cleaned up and secure,
ii) ensure field book and field forms have been updated and are complete,
iii) ensure soil sample locations have been re staked,
iv) allow sufficient time to package, log and ship samples.
v) ensure collected field data is properly logged and filed.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 5

MONITORING WELL, PIEZOMETER, AND TEMPORARY WELL CONSTRUCTION AND DEVELOPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

New overburden monitoring wells, piezometers, and temporary wells will be installed during the field investigation. The total depth of the wells and piezometers will vary depending upon the depth to the water table at each location. Prior to borehole advancement and monitoring well installations, the field geologist will review existing Site-specific geologic and hydrogeologic information.

Details regarding borehole advancement and soil sampling for stratigraghic characterization are provided in SOP 3.

PRIOR PLANNING AND PREPARATION

The following activities must be undertaken prior to installing groundwater monitoring wells, temporary wells, and piezometers.

i) Review the Work Plan, Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.
ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.
iii) Obtain a site plan and review any existing stratigraphic information. Determine the exact number and location of boreholes to be installed and the depths of samples for chemical analysis. Assemble sample containers if needed.
iv) Review with Field Supervisor and/or Site Safety Officer to determine whether UXO is a concern in the work area and assure the appropriate UXO clearance activities have been arranged pursuant to Section 2.3.2 of the FSP and Section 14 of the HASP.
v) Review with Field Supervisor whether utility clearance activities have been completed in the areas where subsurface investigations are to be conducted.
vi) Establish borehole locations in field using available landmark or by surveying methods if necessary.
vii) Evaluate access conditions with the Field Supervisor to determine whether any vegetation clearing is necessary to access investigative locations and coordinate required approvals of clearing activities with the FWS.
viii) Establish a water source for drilling and decontamination activities. Review procedures for handling and disposal of drill cuttings, wash waters, and spent decontamination fluids in Section 2.4 of the FSP.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 5

MONITORING WELL, PIEZOMETER, AND TEMPORARY WELL CONSTRUCTION AND DEVELOPMENT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

EQUIPMENT NEEDS

The following is a list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment; additional equipment may or may not be required for any specific task.

- equipment decontamination supplies;
- field book, field forms (hard copy or electronic);
- well development pumps;
- water level meter:
- portable electric power supply;
- surge block/bailer
- polyethylene tubing and stainless steel fittings;
- air monitoring equipment;
- PPE as specified in the HASP;
- cooler and ice;
- 5-gallon buckets and or portable tanks;
- water quality meters (pH, Conductivity, temperature, and turbidity)
- camera; and
- re-sealable baggies;

PROCEDURE

LOCATION AND MARKING OF DRILL SITES/FINAL VISUAL CHECK

The proposed borehole locations marked on the site plan will be located in the field and staked. Once the final location for the proposed boring has been selected and utility and UXO clearances are complete, one last visual check of the immediate area should be performed before drilling proceeds. This last visual check should confirm the locations of any adjacent utilities (subsurface or overhead) and verification of adequate clearance. If gravity sewers or conduits exist in the area, any access manholes or chambers should be opened and the conduit/sewer alignments confirmed, if possible.

If it is necessary to relocate any proposed borehole due to terrain, utilities, access, etc., the Field Supervisor must be notified and an alternate location will be selected.

Details regarding borehole advancement are provided in SOP 3.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 5

MONITORING WELL, PIEZOMETER, AND TEMPORARY WELL CONSTRUCTION AND DEVELOPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

EQUIPMENT DECONTAMINATION FOR ENVIRONMENTAL SITES

Prior to use and between each borehole location follow the equipment decontamination procedures outlined in SOP 1 and SOP 2.

OVERBURDEN MONITORING WELLS

The geologist prior to well installation will review available information pertaining to geology and water levels of existing monitoring wells in the area. Details regarding borehole advancement are provided in SOP 3.

Specific installation protocols for the overburden monitoring wells are described below:

i) The screened interval for the monitoring wells will target the upper 10 feet of the water table. Boreholes for monitoring wells will be advanced to the target depth (5 to 7 feet below the water table) using a rotary drill rig equipped with at least 8-inch outer diameter (OD) 4.25-inch inner diameter (ID) hollow-stem augers (HSA). Soil samples will be collected continuously during borehole advancement using a 2- inch diameter split spoons for lithologic logging field screening, and chemical analysis, where specified. (See SOP 3).

ii) A 10-foot length of nominal 2-inch diameter 0.010-inch machine slotted type 316 stainless steel no. 10 slot well screen will be attached to one 10-foot length of flush-threaded type 316 stainless steel riser and lowered into the annulus of the HSA (any writing on the casing or screen will be removed prior to installation). Two-inch diameter flush-threaded schedule 40 PVC riser pipe will then be attached to the stainless steel riser pipe in 10 foot lengths as the assembly is lowered into the borehole. This will cease when the bottom of the screen has reached the base of the borehole and there is a sufficient length of riser pipe to extend above the ground surface. No lubricating oils or grease shall be used on casing threads. Teflon tape may be used to wrap the threads to insure a tight fit and minimize leakage. No glue of any type shall be used to secure casing joints. The riser pipe will be cut to a convenient length and a slip cover placed over the top of the pipe to prevent foreign particles from entering the well annulus during auger removal. (Note: some five-foot screens will be available)

iii) A filter sand pack will consist of clean washed, well-rounded silica sand of a gradation appropriate for the screen and the formation (20-40 gradation or equivalent). The filter pack will extend a minimum of 0.5-foot below, and a minimum of 2 feet above the top of the screen. The sand will be installed using a tremie pipe as necessary as the HSAs are removed to prevent bridging of the sand pack in the annular space between the borehole wall and the outside of the well materials. If a tremie pipe is not used, the top of the sand pack will be measured frequently during installation and then at completion. Measurements will be made at various lateral locations around the screen and riser (not just at the same plan-view location). The final depth to the top of the filter pack shall be directly measured and recorded.

iv) A minimum 2-foot thick seal will be placed in the annual space above the filter pack sand. The seal will consist of 3/8-inch diameter bentonite pellets. As the bentonite pellets are placed, about 1 gallon of potable water per foot of pellets will be added to initiate hydration of the bentonite. The pellets will be allowed to hydrate for a minimum of 30 minutes or per the manufacturer's recommended hydration time, which ever is greater, prior to continuing with well construction activities. The bentonite seal will be placed immediately after installing the filter pack, unless initial development is warranted (to seat the filter pack) prior to placement of the seal, in which case the seal shall be placed immediately upon completion of the initial development.

v) The annular space between the well casing and the boring in the wells will be filled with a cement/bentonite grout from the top of the bentonite seal to within 3 feet +/-0.5 ft below the ground surface. The cement/bentonite grout mixture will consist of approximately nine parts Type I Portland cement to one part bentonite (equivalent to one 94-pound bag of cement to about 10 pounds of bentonite powder) added to about 20 gallons of potable water. The grout will be prepared in an above-ground rigid container by first thoroughly mixing the bentonite powder with water and then mixing in the cement. Grout will be placed in the well annulus with a tremie pipe, with the discharge of the pipe submerged, if necessary, to prevent bridging. The bottom of the tremie pipe will be constructed to direct the discharge to the sides rather than downward. The HSAs will be incrementally removed with intermittent grout addition.

vi) Following placement of the cement/bentonite grout, and allowing a minimum 24-hour curing time for the grout, the remaining 3 feet of annular space will be filled with concrete. The concrete will consist of a sand/gravel premix or ready-mixed concrete.

vii) During placement of the concrete surface seal, the well riser will be cut to its final length using a pipe cutter, a 6-inch ID, 5-foot long, pre-painted steel protective casing with a lockable cover will be placed over the monitoring well casing. The protective casing will be placed approximately 2 feet into the concrete surface seal, leaving approximately 3 feet above the ground surface (additional concrete may be added to fill the inside of the protective casing so that the level of concrete inside of the protective casing is at or above the level of the surface pad). The casing will have weep holes drilled near the base above the concrete pad to prevent water from standing inside the protective casing. A portion of the annulus between the protective casing and riser pipe will be filled with pea gravel to ensure the riser is centered within the casing. A minimum 6-inch thick concrete surface pad will be installed around the protective cover extending a minimum of 1.5 foot radius (3-foot diameter) around the cover. 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 1 inch of the finished pad should be below grade to prevent washing and undermining by soil erosion. Alternately a flush-mount roadway box (depending on location-specific conditions) will be installed over the well.

viii) The north side of the top of the well riser pipe will be notched slightly using a file or knife. This will serve as the reference point for the elevation survey and future hydraulic monitoring activities. The well head will be fitted with a vented cap and an identification tag that identifies the well. Wells will be keyed alike.

ix) Four (pre-painted yellow) cement-filled 4-inch diameter steel guard posts (filled to the top) will be installed around the perimeter of the monitoring well (above grade wells only) and cemented in place. Guard posts will be installed to a minimum depth of 30 inches, protrude at least 4 feet above the surface, and be painted with an caution yellow oil-based paint .

At locations where the water table is shallow (less than 10 feet below ground surface), the well screen will be emplaced to a sufficient depth to allow for installation of the sand pack (2-feet above the top of the screen), bentonite pellet seal (2 feet above the top of the sand pack), and concrete surface seal (3 feet below ground surface). In this situation the field geologist will ensure that stainless steel casing is used, since the water table will be in contact with the well casing.

Note: The field geologist will attempt to complete well installation activities on the same day that the work is commenced. However, circumstances may arise during the installation process, which delays the installation activities until the following days. If these delays result in unsafe work conditions, well installations will be interrupted at a convenient point (such as after the seal has been placed) to ensure safe work conditions for personnel. In addition well installation/drilling activities will also be interrupted at anytime when severe weather conditions (i.e. lightning) is present. Issues regarding safety shall take precedence over any schedule related issues.

HYDRAULIC MONITORING PIEZOMETERS AND TEMPORARY WELLS

In areas of the Refuge where additional hydrogeologic information regarding groundwater flow conditions is needed, hydraulic monitoring piezometers will be installed within the overburden.

DPT groundwater samples will be collected using a Geoprobe™ SP-15 sampler, or similar or by temporary well installations. The SP-15 sampler will be the preferred method for the collection of groundwater screening samples. However, the stratigraphy beneath the Refuge consists primarily of low permeability silt and clay and, as such; the SP-15 sampler may not be a practicable method of collection due to slow recharge rates. If slow recharge rates are encountered in an area, temporary wells will be installed using a DPT rig to collect the groundwater screening samples.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 5

MONITORING WELL, PIEZOMETER, AND TEMPORARY WELL CONSTRUCTION AND DEVELOPMENT CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Piezometer Installation Procedures

Specific installation protocols for the overburden piezometers are described below:

i) Boreholes will be advanced using a DPT rig with 2.125-inch OD probe rods to the target depth (approximately 5 to 7 feet below the top of the overburden water table).
ii) A 5-foot length of nominal 0.75-inch diameter (No. 010 slot) schedule 40 PVC pre-packed well screen attached to a sufficient length of 0.75-inch diameter schedule 40 PVC riser pipe to extend to the surface will be placed into the borehole.
iii) A filter sand pack consisting of a clean inert, filter silica sand (20-40 gradation or equivalent) will be installed to a minimum height of 2 feet above the top of the pre-packed screen. The sand will be added slowly and carefully to the borehole to minimize the potential for bridging.
iv) A minimum 2-foot thick seal consisting of bentonite chips will be placed on top of the sand pack in 1-foot lifts and hydrated using distilled water between lifts.
v) After approximately 30 minutes following hydration of the last lift of bentonite pellets, the borehole annulus above the bentonite seal will be sealed to within 2 feet of the surface using a cement/bentonite grout consisting of approximately nine parts Type I Portland cement to one part bentonite (equivalent to one 94-pound bag of cement to about 10 pounds of bentonite powder added to about 20 gallons of potable water).
vi) The remaining portion of the annulus will be filled with concrete, and a 2- or 4-inch ID, 5-foot long, steel protective casing (pre-painted yellow) with a lockable cover or flush-mount roadway box (depending on location-specific AUS OU conditions) will be installed over the piezometer and cemented in place.
vii) The top of the north side of the casing will be notched slightly using a file or knife. This will serve as the reference point for the elevation survey and future hydraulic monitoring activities. The well head will be fitted with a vented cap and an identification tag that identifies the piezometer.
viii) Three cement-filled 2-inch diameter steel guard posts will be installed around the perimeter of the piezometer (above grade piezometers only) and cemented in place. Guard posts will be installed to a minimum depth of 30 inches, protrude at least 4 feet above the surface, and be painted in the upper 2 feet with an oil-based paint (of a color to be determined by the FWS).

At locations where shallow water table conditions are present the height of the sand pack above the piezometer screen and the thickness of the bentonite seal may be reduced to facilitate piezometer installation.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 5

MONITORING WELL, PIEZOMETER, AND TEMPORARY WELL CONSTRUCTION AND DEVELOPMENT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Temporary Well Installation Procedures

The temporary wells will be installed using the same procedures described for the piezometers except, since the temporary wells are intended to be temporary to facilitate the collection of groundwater screening samples, items vi) and viii) above will be omitted. Instead a lockable cap and lock will be placed on the well. Once the temporary well has been sampled and the resulting data reviewed the well will be closed. Closure of the temporary well will be accomplished by filling the removing the temporary well casing and screen and then filling the resulting hole with a cement bentonite grout. The upper 0.5 feet will be capped with soil from the surrounding area.

WELL DEVELOPMENT

Monitoring Wells

In order to establish good hydraulic communication with the water-bearing unit and reduce the volume of sediment in the monitoring well, both newly installed and selected existing monitoring wells will be developed. Monitoring wells will be developed no sooner than 24 hours following installation.

Monitoring well development will be conducted in accordance with the procedure outlined below:

i) Prior to development the depth to water and total depth will be measured;
ii) plastic sheeting will be placed around the well;

iii) surge the screened interval of the monitoring well using a pre-cleaned surge block or bailer of an appropriate diameter;
iv) purge the monitoring well using a stainless steel cased electronic or pneumatic submersible pump;
v) measure the pH, temperature, turbidity and conductivity of the purged water at initially and then regular intervals using field instruments. Calibrate these instruments daily according to the manufacturer's specifications or QAPP specifications. Additionally, record observations such as color, odor, recharge and turbidity of the purged water. (Note measurements for DO and redox are not measured during well development as these parameters cannot be accurately measured during the development process.)
vi) continue development until the turbidity and silt content of the monitoring well is significantly reduced and three consecutive and consistent readings of pH, temperature, and conductivity are recorded, or a minimum of five well volumes are purged as calculated below for 2-inch diameter wells:

$$V_p = 10(0.16H)$$

where: V_p = purge volume
H = height of the water column in the well
$0.16H$ = one well volume (gallons)

Three consistent readings for pH, temperature, and conductivity are defined for the purpose of monitoring well development as three consecutive readings within 5 percent of the median of the last three readings;

vii) following well development the water level and total depth will be re-measured.

In the event that a monitoring well is purged dry prior to the removal of five well volumes, development will consist of purging the well dry three times. If slow/poor recovery rats are encountered (i.e., purged dry), a pre-cleaned stainless steel bailer may be used to complete the development.

Development data will be documented on standard Well Development and Stabilization Forms (see Appendix B). Alternately, electronic forms may be used. Information noted below that is not included on the well development/stabilization form will be noted in the field book. Information to be recorded on the Well Development and Stabilization Form and/or field book includes:

i. project name, location, well designation
ii. location, date and time of well installation (as recorded on the well instrumentation log)
iii. date and time of well development
iv. static water level from top of well casing before and 24 hours after development,
v. quantity of water lost during drilling, removed prior to well insertion, lost during thick fluid displacement, added during granular filter placement, quantity of fluid in well prior to development and standing in -well contained in saturated annulus (assume 30 percent porosity)
vi. field parameter measurements,
vii. depth from top of well casing to bottom of well,
viii. screen length
ix. depth from top of well casing to top of sediment inside well before and after development (from actual measurements at time of development)
x. physical character of removed water, to include changes during development in clarity, color, particulates, and any noted odor
xi. type and size/capacity of pump and or bailer used, description of surge technique, if used
xii. height of well casing above ground surface (from actual measurement at time of development)
xiii. typical pumping rate estimated recharge rate
xiv. quantity of fluid/water removed and time for removal.

Piezometer/Temporary Well Development

Piezometers and temporary wells will be developed by surging and purging using a mini bailer. Development will consist of purging 3 to 5 well volumes of water from the piezometer/well. In the event that a piezometer/well is purged dry prior to the removal of three well volumes, development will consist of purging the piezometer/well dry twice.

WELL INSTALLATION DOCUMENTATION

Details of each overburden well and piezometer/temporary well installation shall be recorded on the Stratigraphy Log and recorded within a standard field book. Overburden Instrumentation Log is used for recording the overburden well and piezometer/temporary well instrumentation details, this figure will note:

- borehole depth and diameter;
- well screen interval;
- filter pack interval;
- seal/plug interval;
- grout interval;
- surface cap detail;
- screen and casing material;
- well instrumentation (i.e., riser and screen length, slot size);
- well diameter;
- filter pack material;
- type of seal;
- type of grout;
- stick-up/flush-mount detail; and
- date installed.

Manufacturer information associated with the materials used to construct the monitoring wells, temporary wells and piezometers will be maintained in the main field book in the field office. If during the RI materials from different manufacturers are used this information will be noted.

FOLLOWUP ACTIVITIES

The following activities should be completed at the end of each day.

i) prior to leaving a work area, make sure equipment and supplies are secure and the work area is cleaned up and secure,
ii) ensure field book and field forms have been updated and are complete,
iii) ensure the completed well has bee locked and labeled,
iv) allow sufficient time to package, log and ship samples.
v) ensure collected field data is properly logged and filed.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 6

GROUNDWATER AND FLUID LEVEL MONITORING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

The measurement of fluid levels (groundwater or phase-separated fluids) in monitoring wells and piezometers will be performed during the RI. Gauging will be performed at the newly installed piezometers and monitoring wells and at existing monitoring wells present in the AUS OU site to be investigated. In conjunction with groundwater level measurements, surface water (e.g., ponds, lakes, rivers, and lagoons) levels will be monitored as well. This information is critical in understanding the hydrogeologic setting of the site and how contaminants may move beneath the site.

In order to provide reliable data, water levels must be collected over as short a period of time as possible. Groundwater level measurements will be collected at the frequency specified in the Work Plan Appendix B during Phase 1. The measurements (including staff gauge measurements will be collected, if possible, on the same day within a designated sampling area and within as short of a time period as possible within adjacent groupings of AUS areas.

Barometric pressure can affect groundwater levels and, therefore, observation of significant weather changes during the period of water level measurements must be noted. Personnel collecting water level data must note if any of these controls are in effect during the groundwater level collection period. Due to possible changes during the groundwater level collection period, it is imperative that the time of data collection at each station be accurately recorded.

PRIOR PLANNING AND PREPARATION

The following activities must be undertaken prior to undertaking fluid level monitoring:

i) Review the Work Plan, Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.
ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.
iii) Determine the exact number and location of water-level measurements and plan route to optimize collection activities.
iv) Review with Field Supervisor and/or Site Safety Officer to determine whether UXO is a concern in the work area and assure the appropriate UXO clearance activities have been arranged pursuant to Section 2.3.2 of the FSP and Section 14 of the HASP.
v) Double check previous water level and well construction records to ensure the proper locations are being monitored.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 6

GROUNDWATER AND FLUID LEVEL MONITORING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

EQUIPMENT NEEDS

The following is a general list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment, additional equipment may or may not be required for any specific task.

- equipment decontamination supplies;
- field book, field forms (hard copy or electronic);
- water level meter;
- air monitoring equipment
- PPE as specified in the HASP;
- 5-gallon bucket;
- camera; and
- task specific documents and maps.

FIELD PROCEDURES

Once the prior planning and preparation activities are completed, fluid level measurements can proceed. The typical series of events which will take place are:

- well identification/inspection;
- air monitoring;
- reference point determination;
- level measurements;
- equipment decontamination;
- field note completion, review, and checking;
- equipment return; and
- documentation submitted to appropriate staff and files.

Note: Fluid level measurements should follow a logical order from the least known or suspected level of contamination to the greatest. This will minimize the potential for cross-contamination between wells/monitoring locations.

Well Identification/Inspection

Once at the site and prior to fluid level measurements, it is a requirement to confirm that the well to be measured has been correctly identified and located. Numerous wells and well clusters are present at the Refuge such that identification errors can easily occur. The monitoring personnel should be alert to potential cap switching, mislabeled locations or unlabeled wells.

Proper well locations can be determined by comparison of the well log details to measured well details (i.e., total well depth, casing diameter, casing stick-up or stick-down distances), field ties and site plans.

Once the correct monitoring well is identified, a thorough inspection will be completed, and recorded in the field book. Determine if the cap and lock are secure or if they have been tampered with. If the well is unlocked, replace the lock. Any cracks in the protective casing and/or surface seal should be noted, as well as any subsidence or surface water ponding in the vicinity of the well.

Note the results of the well inspection (even if the well is in perfect condition) and inform the Field Supervisor of any well repairs required. Arrange to have any unmarked wells permanently marked for proper identification. (A temporary marking at the time of inspection should also be performed.)

Air Monitoring

Prior to opening the well cap, measure the breathing space above the well casing with a photoionization detector (PID) to establish baseline levels. Repeat this measurement once the well cap is opened. If either of these measurements exceeds any of the air quality criteria established in the HASP, then proper respiratory protection will be required.

Reference Point

Fluid level measurements are made relative to a surveyed reference point. For groundwater level measurements, the reference point is the north side of the top of the well riser or casing. The top of the well riser/casing is usually not level and/or square and, therefore, the reference point must be clearly marked on the riser to ensure consistent readings are obtained from event-to-event. Prior to measuring water levels, a survey mark will be placed on the north side of the monitoring well/piezometer riser pipe for use as a future measuring point for hydraulic monitoring activities, and the elevation of this measuring point will be surveyed to an accuracy of 0.01 feet. The surveyor will also survey the ground surface elevation to determine the actual stick-up height. Clearly marking the reference point will eliminate future measurement errors. If this mark is becoming faded, be sure to remark the reference point to facilitate future consistency in water-level measurements.

Fluid Level Measurements

The following paragraphs describe the most common techniques used to measure fluid levels.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 6

GROUNDWATER AND FLUID LEVEL MONITORING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

A. Electronic Water Level Indicators

Water levels will be obtained by measuring the distance from the top of the riser pipe to the top of the water column using an electronic water level meter. The depth to water will be measured from a fixed reference point on the north side of the well casing. Measurements will be obtained to ±0.01 foot accuracy. Depth to groundwater measurements will be recorded in the field book and/or on the monitoring well gauging log form. Alternatively an electronic form may be used.

The most common method of obtaining water level measurements is the electronic water level indicator (e.g., Solinst meter or Slope Indicator). These meters consist of calibrated cable or tape with a weighted sensing tip at one end. When the tip contacts the water, an electric circuit is completed and the light and/or buzzer signals the contact. The following procedures will be used with electrical water level meters:

i) Check the proper operation of the meter by inserting the tip into water and noting if the contact is registered clearly. Always check to see if the tape has been previously repaired and if a correction of the measurement is required.
ii) Dry the tip and then slowly lower the tip into the well until contact with the water is indicated.
iii) Slowly raise the tip until the light and/or buzzer just begins to activate. This indicates the static water level.
iv) Using the thumb and index finger, grasp the tape at the reference point, and note the reading (to the nearest one-hundredth of a foot).
vi) The reading should be checked two times before removing the tape from the well to ensure accuracy.
vii) Record the water level measurement in the field book and/or water level form. Compare to previous measurements to see if significant changes (i.e., greater than 2 feet) have occurred. Recheck water level if a significant difference is measured.
viii) Once the water level has been measured, lower the water tip of the meter to the base of the well and record the total depth of the well.
ix) Record the total measurement in the field book and/or water level form. Compare to previous measurements to see if significant changes have occurred. Total depth measurements will be used to determine if well re-development maybe required.
x) Decontaminate the submerged end of the tape in accordance with the protocols in SOP 2.

B. Interface Probe

In the event Light Non-Aqueous Phase Liquids (LNAPL); or Dense Non-Aqueous Phase Liquids (DNAPL) are encountered or suspected during the RI, an interface probes will be used to measure the surface of LNAPL layers and the interface between LNAPL and groundwater or groundwater and DNAPL. Electrical water level indicators are not reliable when phase-separated liquids are floating on the water surface.

The interface probe uses an optical liquid sensor, in conjunction with an electric circuit to detect the top of a phase-separated liquid and the interface between the phase layer and water (water level). The procedure for use of this probe is:

i) Lower the probe tip into the well until continuous beeping is heard (this indicates the top of the phase-separated has been detected). Grasp the calibrated tape at the reference point and note reading. Confirm the reading by slowly raising and lowering the probe to the level of the phase layer. (Water is indicated by a discontinuous sound).
ii) Once the top of the phase layer is confirmed, slowly lower the probe until a discontinuous sound is heard. This indicates that the water level has been encountered. Grasp the tape at the reference point and note the reading. Confirm this water level measurement.
iii) Decontaminate the submerged end of the tape and probe prior to the next use in accordance with the protocols described in SOP 2.

C. Surface Water Gauging

Staff gauges will be installed in several water bodies during the RI. The staff gauges will consist of a surveyed fixed reference point located above the water body from which the distance to the top of the surface water body can be measured using a calibrated electronic water-level meter. Such points could include a bridge deck spanning the surface water body or a metal post driven into the bottom of the surface water body.

The distance from the surveyed reference point and the top of the surface water body will be recorded to the nearest 0.01 inch using the calibrated electronic water-level meter when groundwater levels are monitored. The elevation of the surface water body can then be determined at the staff gauge location by subtracting the measured distance from the reference point to the top of the surface water body from the surveyed elevation of the reference point.

Staff gauge measurements will be recorded on the monitoring well gauging log form.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 6

GROUNDWATER AND FLUID LEVEL MONITORING CRAB ORCHARD NATIONAL WILDLIFE REFUGE

FOLLOW-UP ACTIVITIES

The fluid levels must be recorded in a standard bound "survey" type field book or appropriate site-specific forms. The logbook should identify the following:

- identification of measurement point;
- date and time of measurement;
- weather conditions including temperature:
- piezometer/monitoring location condition;
- reference point and reference point elevation;
- measurement method;
- depth to water level;
- presence and depth/thickness of phase-separated liquids; and
- odor (if noted).

The following activities should be completed at the end of each day.

i) prior to leaving a work area make sure equipment and supplies are secure and the work area is cleaned up and secure,
ii) ensure field book and field forms have been updated and are complete,
iii) ensure the monitoring locations have been locked,
iv) return keys and cleaned equipment to the main staging area.
v) ensure collected field data is properly logged and filed.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 7

GROUNDWATER SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

One of the most important aspects of groundwater sampling is acquiring samples that are free of suspended silt, sediment, or other fine-grained particulates. Fine-grained materials may often have a variety of chemical components sorbed onto the particle or have the ability to sorb chemicals from the aqueous phase to the particle that will bias the subsequent analytical results.

> ***Note:*** ***It is common practice to pre-plan the schedule of sampling activities such that sample collection progresses from "clean" to "dirty" areas in an effort to eliminate the potential for cross-contamination. Review previous analytical data (if available) to determine the best sampling sequence.***

PRIOR PLANNING AND PREPARATION

The following shall be considered prior to groundwater sampling:

i) Review the Work Plan, Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.

iii) Assemble site plan, well logs, and previous sampling/purging data that will be required for the planned sample event. Determine the exact number and locations of the wells to be sampled.

iv) Contact the project chemist to arrange:
    - laboratory;
    - glassware;
    - preservatives;
    - filtration information;
    - coolers;
    - shipping details;
    - starting date; and
    - expected duration.

v) Arrange access to the site. Assemble well keys and site keys. Also consider site conditions.

vi) Plan sampling sequence to ensure that "clean" wells are sampled before "dirty" wells to reduce cross-contamination potential.

vii) Plan the sampling sequence to ensure that wells that purge dry fit into the overall sampling schedule to reduce the need for extension of the sampling period and to reduce the need for weekend purging/sampling.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 7

GROUNDWATER SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

EQUIPMENT NEEDS

The following is a general list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment, additional equipment may or may not be required for any specific task.

- equipment decontamination supplies;
- field book, field forms (hard copy or electronic);
- task specific documents and maps
- sample/purge pumps;
- water level meter;
- portable electric power supply or compressed air source;
- Teflon or polyethylene tubing and stainless steel fittings;
- air monitoring equipment
- PPE as specified in the HASP;
- cooler and ice;
- sample containers (sample container and preservative requirements are provided in Table 4.1 of the QAPP)
- 5-gallon buckets and or portable tanks;
- water quality meters (pH, conductivity, temperature, redox, DO, and turbidity)
- camera; and
- re-sealable baggies;

FIELD PROCEDURES

Well Identification/Inspection

Once at the well location and prior to sample collection activities, it is a requirement to confirm that the well to be sampled has been correctly identified and located. The sampler should be alert to potential cap switching, mislabeled locations, or unlabeled well sites.

Proper well locations can be determined by checking well identification tags (if present) and comparison of the well log details to measured well details (i.e., total well depth, casing diameter, casing stick-up or stick-down distances), field ties, and site plans.

Once the correct monitoring well is identified, a thorough inspection shall be completed and recorded in the sampling field book, to determine if the well is suitable for sampling. Determine if the cap and lock are secure or if there is evidence of tampering. If the well is unlocked, replace the lock. Any cracks in the protective casing and/or surface seal should be noted, as well as any subsidence in the vicinity of the well.

Note the results of the well inspection (even if the well is in perfect condition) and inform the Field Supervisor of any well repairs required. Arrange to have any unmarked wells permanently marked for proper identification. (A temporary marking at the time of sampling should also be performed.) If well identification tags or markings appear to be fading, arrange to have the tags or marking replaced. Verify that at least 14-days have passed between development and sampling.

Air Monitoring

Prior to opening the well cap, measure the breathing zone above the well casing with a photoionization detector (PID) to establish baseline levels. Repeat this measurement once the well cap is opened. If either of these measurements exceed any of the air quality criteria established in the health and safety plan, then appropriate respiratory protection will be required.

Water Level Monitoring/Well Depth Sounding

Prior to commencing the groundwater purging/sampling tasks, a water level must be obtained to determine the well volume and for hydraulic purposes. Refer to SOP 6 for procedures to be followed.

GROUNDWATER SAMPLING

Monitoring Wells

Groundwater samples will be collected from AUS OU site monitoring wells the procedures specified below:

i) A new pair of disposable nitrile gloves (or equivalent) will be donned at each location. Ensure that all sampling equipment has been properly decontaminated pursuant to SOP 2 and that all instruments have been properly calibrated.

ii) Place a clean section of plastic sheeting around the well.

iii) Measure the depth to water in each well to the nearest 0.01 foot using a pre-cleaned electronic water level meter (see SOP 6). The depth to water will be measured from a fixed reference point on the north side of the well casing. Well depth should be obtained from the well log. Measure well depth after sampling is completed, to minimize re-suspension of settled solids.

iv) Purging will be conducted using a pre-cleaned stainless steel bladder pump with a Teflon bladder, stainless steel electric submersible pump (Grundfos® or similar). Each pump will be fitted with a sufficient length of Teflon tubing dedicated to the well. Teflon tubing will be used at permanent monitoring well locations being sampled for VOCs; if the monitoring well is not being sampled for VOCs then polyethylene tubing will be used. **Lower the pump or tubing**

very slowly into position to minimize mixing of the stagnant well casing water and to minimize the agitation of any solids into suspension, which will increase purging time. Position the pump or tubing in the well such that the intake corresponds to the approximate middle of the well screen (portion of screen under water). If possible, a minimum of 2 feet should be maintained between the pump intake and the well bottom or sediment level, if present.

v) Purge the monitoring well purging at a pumping rate of between 100 and 500 milliliters per minute (mL/min). The pumping should commence at a very low flow rate and be increased slowly to minimize the agitation of solids.

vi) Measure the groundwater level with an electronic water level meter while purging with a goal of less than 0.3 feet of drawdown while purging (if possible). Adjust the flow within the specified range as necessary.

vii) Measure water field parameters approximately every 3 to 5 minutes using a flow-through cell and a turbidity meter. If purge water initially appears turbid, continue purging until the purge water becomes visibly less turbid before connecting the flow-through cell.

viii) Continue purging until field parameters have stabilized. Stabilization is achieved after all parameters have stabilized for last three consecutive readings and are within the following limits:

pH	±0.1 pH units;
temperature	±0.5 degrees Celsius or ±1 degree Fahrenheit;
conductivity	±10 percent;
dissolved oxygen	±0.1 mg/L and
turbidity	±10 percent or a final value of less than 10 nephelometric turbidity units (NTU).

ix) Disconnect the tubing from flow-through cell and collect groundwater through the tubing directly into laboratory supplied containers in order of decreasing analyte volatility using techniques that minimize sample agitation.

Samples should be collected and containerized in the order of the following volatilization sensitivity:

- volatile organic compounds;
- semivolatile organic compounds;
- total organic carbon;
- total organic halogens;
- extractable organics;
- total metals;
- dissolved metals;
- phenols;
- cyanide;
- sulfate and chloride; and
- nitrate and ammonia.

Samples collected for dissolved analyses will be field filtered using a dedicated 0.45-micron filter prior to the addition of sample preservative. Groundwater samples must be labeled immediately and placed into a cooler containing ice as described in Section 5.3 and SOP 9 of the FSP.

x) In the event that the groundwater recharge to the monitoring well is insufficient and the well will be pumped to dryness or the field parameters fail to stabilize following the removal of five well volumes, groundwater will be allowed to recover to a level sufficient for sample collection. Upon recovery, groundwater samples will be collected as described in Item viii). Alternately, if a well is purged dry prior to stabilization, after allowing the well to recover, a new disposable Teflon bailer and a new section of braided nylon rope may be used to collect the groundwater sample.

Groundwater Screening Samples

DPT groundwater samples will be collected using a Geoprobe™ SP-15 Sampler (with stainless steel screen and no. 10 slot size) or similar, or by installing temporary wells.

The procedures used to collect groundwater screening samples will be as follows:

i) The groundwater sampling tool (Geoprobe™ SP-15, or similar) will be fitted to the end of drill string and advanced to a depth of approximately 5 feet below the water table.
ii) Upon reaching the target depth, the outer sheath will be retracted to expose the well screen.
iii) Prior to sampling, the probe will be purged using a new disposable Teflon bailer, mini-bladder pump, or a new section of Teflon-lined polyethylene tubing equipped with a foot valve, as practicable, until the turbidity of the purged water is significantly reduced.
iv) After purging the required volume, a groundwater screening sample will be collected directly into the laboratory supplied containers for VOC analysis using the same equipment used to purge the well.
v) Laboratory-supplied sample containers will be filled using techniques that minimize sample agitation using the equipment used to purge the temporary piezometer as described above.
vi) Groundwater samples must be labeled immediately and placed into a cooler containing ice as described in Section 5.3 and SOP 9 of the FSP.

Items iii through v will be followed if samples are collected from a temporary well.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 7

GROUNDWATER SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

FIELD NOTES AND DOCUMENTATION

The field notes must document all the events, equipment used, and measurements collected during the sampling activities. The field notes must be legible and concise such that the entire sample event can be reconstructed later for future reference.

The field notes will be recorded in a standard bound 'survey' type field book issued for general note taking/field records.

The logbook should document the following for each well sampled:

- identification of well,
- well depth,
- static water level depth and measurement technique,
- sounded well depth,
- presence of immiscible layers and detection/collection method,
- well yield - high or low,
- purge volume and pumping rate,
- time well purged,
- measured field parameters,
- purge/sampling device used,
- sample appearance,
- sample odors (if respiratory protection is not required),
- sample identification numbers,
- depth of sample collection,
- collection of QA/QC samples,
- decontamination procedure,
- preservative(s) used,
- parameters requested for analysis,
- field analysis data and method(s),
- sample distribution and transporter,
- laboratory shipped to,
- chain-of-custody number for shipment to laboratory,
- field observations on sampling event,
- name of collector(s),
- climatic conditions including air temperature, precipitation, etc., and
- problems encountered and any deviations made from the established sampling protocol.

In addition to the field book, standard field forms will also be used to document groundwater sampling activities (field forms maybe in an electronic format).

FOLLOWUP ACTIVITIES

The following will be performed once field activities are complete.

i) Double check Work Plan to ensure all samples have been collected.
ii) Equipment must be cleaned and returned to the equipment administrator.
iii) Complete purge water disposal, and cleaning fluid disposal requirements per the Work Plan.
iv) Notify the contract laboratory as to when to expect the samples. The chain-of-custody and covering letter, indicating the parameters and number of samples, shall be enclosed in the sample cooler.
v) Complete and file the appropriate forms/data files and data sheets.
vi) Return site/well keys.

SOP 8

SINGLE-WELL RESPONSE TESTS

GENERAL

Single-well hydraulic response testing will be preformed on newly installed monitoring wells and selected existing monitoring wells identified in the RI/FS Work Plan to estimate the hydraulic conductivity of the overburden stratigraphic unit.

The slug test involves inducing a sudden change in water level in a well and measuring the water level response within that well over time. Water level change may be induced by suddenly injecting or removing a known quantity or "slug" of water into or out of the well, emplacement or removal of a solid slug (i.e., stainless steel, PVC) into the water column, or a release of pressure in a tightly capped well.

PRIOR PLANNING AND PREPARATION

Prior to going into the field to perform the single well response test the following tasks should be under taken:

i) Review the Work Plan, Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.
ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.
iii) Assemble site plan and well logs that will be required for the planned testing event. Determine the exact number and locations of the wells to be tested.
iv) Arrange access to the site. Assemble well keys and site keys. Also consider site conditions.
v) Plan testing sequence to ensure that "clean" wells are tested before "dirty" wells to reduce cross-contamination potential.

Obtain information on each monitoring well to be tested. Information should consist of inside diameter of the well screen and well casing, borehole diameter, depth of well, static water level, and the length and depth setting of the screen.

EQUIPMENT NEEDS

The following is a general list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment; additional equipment may or may not be required for any specific task.

- equipment decontamination supplies;
- field book, field forms (hard copy or electronic);
- task specific documents and maps

- purge pump/bailer;
- water level meter;
- portable computer;
- polyethylene tubing and stainless steel fittings;
- air monitoring equipment
- PPE as specified in the HASP;
- cooler and ice;
- pressure transducer and data logger
- 5-gallon buckets and or portable tanks; and
- camera; and

PROCEDURE

Site-specific procedures for response testing are summarized below:

i) The static water level in the well will be gauged using an electronic water level indicator (see SOP 6);
ii) Testing equipment will be decontaminated prior to each response test (see SOP 2 (using same procedure outline for water level meters));
iii) A 10 pound per square inch (PSI) pressure transducer attached to an electronic data logger will be lowered into the well;
iv) A pre-cleaned electric submersible pump or tubing attached to a peristaltic pump will be fully submerged in the monitoring well and the water level will be allowed to equilibrate to its original level;
v) The water level in the well will be lowered by operating the pump; and
vi) Water level recovery into the well will be monitored and recorded by the data logger.

Single well hydraulic response testing will be conducted following the first groundwater sampling round.

At the completion of the test, the non-dedicated equipment shall be properly decontaminated per SOP 2 (Appendix A).

Under some conditions (i.e., very permeable formations) the slug test can best be conducted by simulating the withdrawal/injection of a slug of water by the release of pressure in a tightly capped well. The following steps need to be performed:

i) Insert the pressure transducer at a sufficient depth below the water table. Check the operation of the transducer and data recorder.
ii) Install sealed well cap with a pressure cap.
iii) Increase the pressure in the well to lower the water level (usually a bicycle pump is a sufficient source of compressed air).
iv) Release the pressure by opening a valve on the well cap and allow well to recover.

v) Water level recovery into the well will be monitored and recorded by the data logger.

Water levels will be measured using a pressure transducer to record hydraulic head changes. The rate of recovery is a function of the hydraulic conductivity of the formation. Water level recovery data recorded by the data logger will be downloaded into a personal computer and evaluated using the methods developed by Bouwer and Rice using AQTESOLV™ software by HydroSolve, Inc.

FOLLOWUP ACTIVITIES

The following shall be performed once field activities are complete.

i) Double check Work Plan to ensure all locations have been tested.
ii) Equipment must be cleaned and returned to the equipment administrator.
iii) Complete purge water disposal, and cleaning fluid disposal requirements per the Work Plan.
iv) Complete and file the appropriate forms and data files.
v) Return site/well keys.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 9

SAMPLE MANAGEMENT AND FIELD QA/QC
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

Sample management is the continuous care given to each sample from the point of collection to receipt at the analytical laboratory. Good sample management ensures that samples are properly recorded, properly labeled, not lost, broken, or exposed to conditions, which may affect the sample's integrity. All sample submissions must be accompanied with a chain-of-custody (COC) document to record sample collection and submission.

PRIOR PLANNING AND PREPARATION

The following shall be considered prior to performing sampling activities:

i) Review the Work Plan, Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.
ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and decontaminate and calibrate as needed.
iii) Assemble site plan, well logs, and previous sampling data that will be required for the planned sample event. Determine the exact number and locations to be sampled and the types of media samples to be collected.
iv) Contact the project chemist to arrange:
    - laboratory;
    - glassware;
    - preservatives;
    - filtration information;
    - coolers;
    - shipping details;
v) Arrange access to the sampling site. Assemble well keys and site keys as required. Also consider site conditions.

FIELD HANDLING

Prior to entering the field area where sampling is to be conducted, especially at sites with defined exclusion zones, the sampler should ensure that all materials necessary to complete the sampling are on hand.

If samples must be maintained at a specified temperature after collection, proper coolers and ice/cool-packs must be brought out to the field. Consideration should be given to keeping reserve cooling media on hand if sampling events will be of long duration. Conversely, when sampling in extremely cold weather, proper protection of water samples, trip blanks, and field blanks must be considered.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 9

SAMPLE MANAGEMENT AND FIELD QA/QC
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Personnel performing sampling tasks must check the sample preparation and preservation requirements to ensure compliance with the project QAPP. Typical sample preparation may involve pH adjustment (i.e., preservation), sample filtration and preservation, or simply cooling to 4°C. Sample preparation requirements vary from site to site and vary depending upon the analytical method for which the samples will be analyzed.

SAMPLE LABELING

The sample labels will include a unique sample identification number, include the sampler's initials, and specify if the sample is grab or composite, the place of collection, the date of collection, and the analyses to be performed. The sample identification format for this investigation has been designed to uniquely identify each sample from each sampling program and event.

An example of the sample format is as follows, and is described below:

AUS-0A2B-004-SL-005

AUS- 0A2B-004-SL-05:	All samples will have the "AUS" prefix;
AUS- 0A2B-004-SL-05:	The second part of the number identifies the AUS OU Site. The example describes Area 2B;
AUS- 0A2B-004-SL-05:	The third part of the number identifies the sample location within that Site;
AUS- 0A2B-004-SL-05:	The fourth part of the number identifies the media (SS=soil, SD=sediment; GW=groundwater; SW=surface water; SL=sludge). The fourth part also identifies a QC sample where appropriate (EB=equipment rinsate blank; AB=ambient blank; TB=trip blank);
AUS- 0A2B-004-SL-05:	If applicable, the last part of the number identifies the sample depth in feet, to the nearest foot of the bottom of the sample interval. "0X" in the fifth position indicates a sample collected from the surface to a depth of 6 inches.

For samples of waste material and samples collected from tanks or roll-off boxes, the fourth and fifth positions will be replaced by a four-digit descriptor such as "Tank" for a waste water sample. Duplicate samples will be numbered sequentially starting with 5000. This will ensure that duplicate samples cannot be distinguished from the original sample at the laboratory. The notes taken in the field log will detail the original sample for which it is a duplicate.

Sample information will be written on the labels using waterproof, non-erasable ink. The adhesive labels will be secured to the bottle. The labels will be further secured to the sample container using wide clear tape over the label and completely around the container before packing in a cooler for secure label protection during transportation and at the laboratory. The sample team members will ensure that the clear tape is not placed across the cap of the sample container.

PACKAGING

When possible, sample container preparation and packing for shipment should be completed in a well-organized and clean area, free of any potential cross-contaminants. Sample containers should be prepared for shipment as follows:

i) Containers should be wiped clean of all debris/water using paper towels (paper towels must be disposed of with other potentally contaminated materials).
ii) Clear, wide packing tape should be placed over the sample label for protection (if not already completed).

While there is no one "best" way to pack samples for shipment, the following packing guidelines should be followed.

i) Plan time to pack your samples (and make delivery to shipper if applicable). Proper packing and manifesting takes time. (A day's worth of sampling can be easily wasted due to a few minutes of neglect when packing the samples).
ii) Always opt for more coolers and more padding rather than crowding the samples. The cost and lost time associated with the packing and shipment of additional coolers is usually always small in comparison with re-sampling due to breakage during shipment.
iii) Do not bulk pack. Each sample must be individually padded.
iv) Large glass containers (1 liter and up) require much more space and padding between containers.
v) Ice is not a packing material due to the reduction in volume when it melts.

The following is a list of standard guidelines, which must be followed when packing samples for shipment.

i) Remember that the laboratory to which the samples will be shipped depends on the analysis to be performed. Consult the QAPP or Section 5.5 of the FSP to determine the appropriate analytical laboratory and plan accordingly during sample packaging.
ii) Line the inside of the cooler with a plastic liner or bubble wrap.
iii) When using ice for a cooling media, always double bag the ice in "Zip-Lock" bags to minimize the potential for leakage.
iv) Bubble wrap will be used to cushion individual sample containers.
v) Double-check to ensure temperature blanks have been included for all shipments and trip blanks are included in coolers containing VOCs, or where otherwise specified in the QA/QC plan. A trip blank will accompany each shipment of

multiple groundwater and/or surface water samples submitted for analysis of VOCs.

vi) Prior to sealing the cooler double check the samples in the cooler with the samples listed on the corresponding Chain-of-Custody form.

vii) Enclose the completed and signed Chain-of-Custody form in a "Zip-Lock" bag. Each cooler shipped will contain at least one Chain-of-Custody form that identifies the samples contained in that cooler.

ix) Ensure custody seals/custody tape and/or seal is placed on each cooler. Coolers with hinged lids should have seals placed on the opening edge of the lid. Coolers with "free" lids should have seals placed on opposite diagonal corners of the lid. The seal will secure the lid and provide evidence that the samples have not been tampered with en-route to the project laboratory. Clear tape will be placed over the chain-of-custody seals to ensure that they are not accidentally broken during shipment.

x) Ensure that all "Hazardous Material" stickers/markings or previous shipping labels have been removed from coolers being used which previously contained such materials.

> *Note: Never store clean sample containers in enclosures containing equipment that uses any form of fuel or volatile petroleum based product. An alternate means of secure storage must be planned for.*
> *When conducting sampling in freezing conditions at sites without a heated storage area (free of potential cross contaminants), trip blanks and temperature blanks not being used in a QA/QC role should be isolated from coolers immediately after receipt. Trip and temperature blanks should be double-bagged and kept from freezing.*

CHAIN-OF-CUSTODY RECORDS

Each sample cooler being shipped to the laboratory will contain a chain-of-custody form. The chain-of-custody form will consist of four copies which will be distributed as follows: the shipper will maintain a copy while the other three copies will be enclosed in a waterproof envelop within the cooler with the samples. The cooler will then be sealed properly for shipment. The laboratory, upon receiving the samples, will complete the three remaining copies. The laboratory will maintain one copy for their records. The executed original will be returned to ENTRIX with the data deliverables package. Copies of the COC will also be provided to NewFields Companies, L.L.C. (NewFields) as well as a copy of the laboratory electronic data deliverable (EDD).

The chain-of-custody record, completed at the time of sampling, will contain, but not be limited to, the sample number, date and time of sampling, and the name of the sampler. The chain-of-custody document will be signed and dated by the sampler when transferring the samples.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 9

SAMPLE MANAGEMENT AND FIELD QA/QC
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

The following list provides guidance for the completion and handling of all COCs.

i) COCs used should be standard forms supplied by the project analytical laboratory (STL). (No COCs forms from other labs will be used, even if the heading is blocked out)
ii) COCs must be completed in black ball-point ink only.
iii) COCs must be completed neatly using printed text.
iv) If a simple mistake is made, line out the error with a single line and write initials and date next to it.
v) Each separate sample entry must be sequentially numbered.
vi) The use of "Ditto" or quotation marks to indicate repetitive information in columnar entries should be avoided. If numerous repetitive entries must be made in the same column, place a continuous vertical arrow between the first entry and the next different entry.
vii) When more than one COC form is used for a single shipment, each form must be consecutively numbered using the "Page ___ of ___" format.
viii) If necessary, place additional instructions directly onto the COC. Do not enclose separate loose instructions.
ix) Include a contact name and phone number on the COC in case there is a problem with the shipment.
x) A copy of the COC must be maintained in the field file.
xi) Do not indicate the source of the sample as this may produce a biased lab result.
xii) Before using an acronym on a COC, define clearly the full interpretation of your designation [e.g., Polychlorinated Biphenyls - (PCBs)].

SHIPMENT

In all but a few cases the QA/QC plan for the field work will require shipment of samples by overnight courier. Many problems can be avoided by proper advance planning.

Prior to the start of the field sampling, the carrier should be contacted to determine if pickup can be made at the field site location. If pickup at the field site can be made, the "no-later-than" time for having the shipment ready must be determined.

If no pickup is available at the site, the nearest manned pickup or drop-off location should be determined. Again, the "no-later-than" time for each location should be determined. Sample shipments must not be left at unmanned, unsecured or questionable drop locations (i.e., if the cooler will not fit in a remote drop box do not leave the cooler unattended next to the drop box).

Some overnight carriers do not in fact provide "overnight" shipment to/from some locations. Do not assume; call the carrier in advance before the start of the field work.

Copies of all shipment manifests must be maintained in the field file.

Analytical hold times will be reviewed prior to collecting samples on Saturday, Sunday or holidays. Samples collected on a Saturday or the day before a holiday will be shipped with additional ice in the coolers. Samples collect on late on a Saturday, on Sunday or on a holiday will be placed in coolers with extra ice. The coolers will be sealed, stored in a secure location, and shipped by the courier on the next business day.

FIELD QUALITY CONTROL/QUALITY ASSURANCE (QA/QC)

To ensure the validity of data from the sampling and analysis program, field Quality Control (QC) samples will be collected and submitted for analysis. Field QC samples consist of field duplicate samples, field equipment rinsate blank samples, trip blank samples, matrix spike/matrix spike duplicate (MS/MSD). Field duplicate samples will be collected during each monitoring event at the frequencies specified in the QAPP.

Equipment Rinsate Blanks

Equipment rinsate blanks are defined as QA/QC samples used to determine if cleaning procedures are effective and adequate. Equipment rinsate blanks are prepared by collecting laboratory supplied deionized water or organic free water that has been "run through" or "poured over" the cleaned sample collection equipment. Equipment rinsate are submitted to the lab "blind". Equipment blanks are typically collected at the sample collection area of the project site.

Preservation or filtration (if required) is completed on the respective blank aliquots to ensure that each step of the sampling procedure is evaluated.

Field equipment rinsate blank samples will not be collected for dedicated or disposable soil or groundwater sampling equipment. Field rinsate blank sample data provide information regarding the efficacy of the equipment decontamination procedures.

Trip Blanks

Trip blank samples will be prepared by the laboratory, shipped with the sample containers, and returned unopened to the laboratory with multiple aqueous samples for VOC analysis. Trip blank sample data provide information on sample cross-contamination by VOCs during sample shipping and storage. The samples should not be opened, and are intended to determine if the sample shipping or storage procedures influence the analytical results.

Field Duplicates

Field duplicates are collected and submitted to assess the potential for laboratory data inconsistency and the adequacy of the sampling and handling procedures. A duplicate sample is collected from the same source utilizing identical collection procedures.

During groundwater sample aliquot collection the original and duplicate sample are collected simultaneously by partially filling the original and then the duplicate and alternating back and forth until both samples have been fully collected. This will provide two representative samples for analyses. Transferring the sample aliquot from a bulk container to the respective sample containers is typically not permissible.

Field duplicates are typically submitted "blind" to the laboratory by providing a false identification number. The sampling key to ensure proper sample identification must be submitted to the appropriate personnel to enable completion of the QA/QC review process.

Matrix Spike/Matrix Spike Duplicate

MS/MSD groundwater samples will be collected from a well representative of the condition of the majority of the monitoring wells. The chain-of-custody forms sent to the project laboratory must identify the samples collected for MS/MSD analysis. Additional sample volume will be provided as necessary to the laboratory for matrix spike/matrix spike duplicate (MS/MSD) analysis. MS/MSD samples are investigative samples that are analyzed by the laboratory to evaluate analytical accuracy and precision relative to the sample matrices.

MS/MSD sample volumes are additional sample aliquots (additional for aqueous samples only) provided to the laboratory to evaluate the accuracy and precision of the sample preparation and analysis technique. Sample labeling identifies the respective sample location and each additional container that is labeled as the "MS/MSD" volume.

APPENDIX B

FIELD FORMS

- Monitoring Well Inspection Checklist
- Stratigraphy Log
- Overburden Instrumentation Log
- Monitoring Well Record for Low-Flow Purging
- Sample Collection Form
- Water Level Records
- Surveyor Data Sheet
- Property Access/Utility Clearance Data Sheet
- Audit Checklist for Monitoring Well Installation
- Audit Checklist for Groundwater Sampling
- Audit Checklist for Soil Sampling
- Audit Finding Report

AUDIT CHECKLIST FOR MONITORING WELL INSTALLATION

Project Name: ______________________________

Project No.: ______________________________

Sampling Personnel: ______________________________

Auditor Name: ______________________________

Field Team Leader: ______________________________

Audit Date: ______________________________

Audit No.: ______________________________

Audit Question	*S*	*U*	*N/A*	*Comments*
Were all personnel briefed on their assignment?	☐	☐	☐	____________
Did the crew have all the forms and maps, equipment, and materials necessary to complete the assigned tasks?	☐	☐	☐	____________
Was the drilling location neat and properly set up?	☐	☐	☐	____________
Were the field meters properly calibrated?	☐	☐	☐	____________
Were tasks completed according to the approved FSP?	☐	☐	☐	____________
Was drilling and sampling equipment properly deconned?	☐	☐	☐	____________
Was IDW properly handled?	☐	☐	☐	____________
Was the well location properly marked by the survey crew?	☐	☐	☐	____________
Did personnel adhere to the safety procedure?	☐	☐	☐	____________

Additional Comments

STRATIGRAPHY LOG (OVERBURDEN)

PAGE ____ OF ____

PROJECT NAME ________________
PROJECT NUMBER ________________
CLIENT ________________
LOCATION ________________
DRILLING CONTRACTOR ________________

DRILLER ________________
SURFACE ELEVATION ________________
TOP OF CASING ________________
WEATHER (A.M.) ________________
(P.M.) ________________

HOLE DESIGNATION ________________
DATE/TIME STARTED ________________
DATE/TIME COMPLETED ________________
DRILLING METHOD ________________
CRA SUPERVISOR ________________

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS			SAMPLE DESCRIPTION	SAMPLE DETAILS							PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – MAIN COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES)				SAMPLE INTERVAL			
						6"	6"	6"	6"				

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING ________ DEPTH OF FIRST GROUNDWATER ENCOUNTER ________ TOPSOIL THICKNESS ________
WATER LEVEL IN OPEN BOREHOLE ON COMPLETION ________, AFTER ____ HOURS ____
COMPLETION DETAILS: ________________

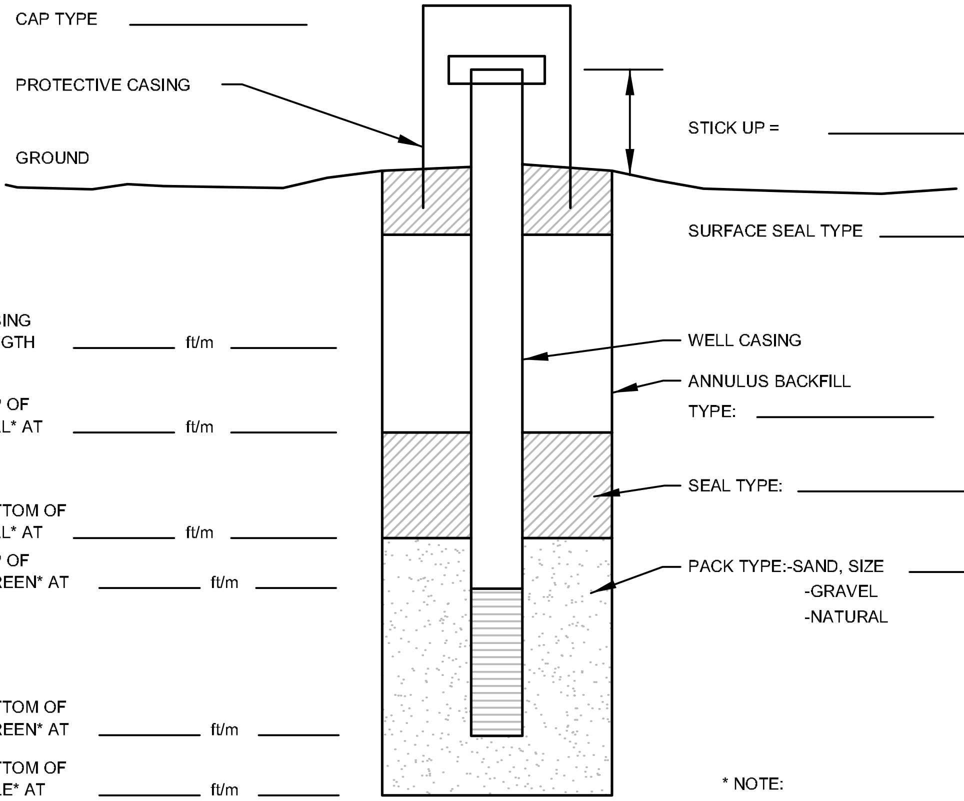
NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

CRA

OVERBURDEN INSTRUMENTATION LOG (page 1 of 2)

PROJECT NAME	HOLE DESIGNATION
PROJECT NUMBER	DATE COMPLETED
CLIENT	DRILLING METHOD
LOCATION	CRA SUPERVISOR
SUBCONTRACTOR	INSTALLER

CAP TYPE



STICK UP = ft/m

SURFACE SEAL TYPE

CASING LENGTH ft/m

TOP OF SEAL* AT ft/m

BOTTOM OF SEAL* AT ft/m

TOP OF SCREEN* AT ft/m

BOTTOM OF SCREEN* AT ft/m

BOTTOM OF HOLE* AT ft/m

DEPTH OF WELL AT ft/m

ANNULUS BACKFILL TYPE:

SEAL TYPE:

PACK TYPE:-SAND, SIZE
-GRAVEL
-NATURAL

* NOTE:
ALL DIMENSIONS ARE
BELOW GROUND SURFACE (BGS)

SCREEN TYPE: ☐ continuous slot ☐ perforated ☐ louvre ☐ other:

SCREEN MATERIAL: ☐ stainless steel ☐ plastic ☐ other:

SCREEN LENGTH: ft/m SCREEN DIAMETER: in/cm SCREEN SLOT SIZE:

WELL CASING MATERIAL: WELL CASING DIAMETER: in/cm

HOLE DIAMETER:

DEVELOPMENT: METHOD: DURATION:

OVERBURDEN INSTRUMENTATION LOG (page 2 of 2)

Quantity and Composition of:

- Grout: ____________________
- Bentonite Seal: ____________________
- Granular Filter Pack: ____________________

Well Screen Details:

- total open area per meter/foot of screen: ____________________
- outside diameter: ____________________
- nominal inside diameter: ____________________
- schedule/thickness: ____________________
- manufacturer: ____________________

Material Between the bottom of the boring and the bottom of the screen:

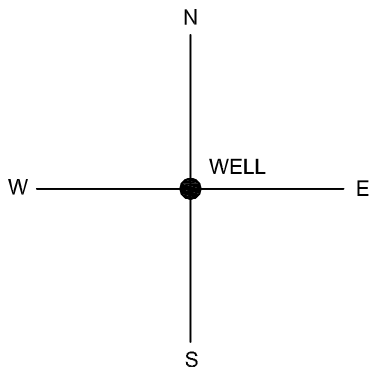
____

Well Casing Details:

- Schedule/thickness: ____________________
- Manufacturer: ____________________
- Joint design and composition: ____________________

Protective Casing Details:

- Composition: ____________________
- Bottom of protective casing below ground surface: ____________________
- Drainage port location and size: ____________________
- Protective post configuration:



Date and Time:

- Well Started: ____________________
- Well Completed: ____________________

Special problems and resolutions: ____________________

Water level after 24 hours after completion: ____________________

Date/Time Measured: ____________________

MONITORING WELL RECORD FOR LOW-FLOW PURGING

Project Data:

Project Name: ____________________ Date: ____________________

Ref. No.: ____________________ Personnel: ____________________

____

Monitoring Well Data:

Well No.: ____________________ Screen Length (ft): ____________________

Measurement Point: ____________________ Depth to Pump Intake (ft)(1): ____________________

Constructed Well Depth (ft): ____________________ Well Diameter, D (in): ____________________

Measured Well Depth (ft): ____________________ Well Screen Volume, V_s (mL)(2): ____________________

Depth of Sediment (ft): ____________________ Initial Depth to Water (ft): ____________________

Time	*Pumping Rate (mL/min)*	*Depth to Water (ft)*	*Drawdown from Initial Water Level (3) (ft)*	*pH*	*Temperature ^oC*	*Conductivity (mS/cm)*	*ORP (mV)*	*DO (mg/L)*	*Turbidity (NTU)*	*Volume Purged, V_p (mL)*	*No. of Well Screen Volumes Purged (4)*

Notes:

(1) The pump intake will be placed at the well screen mid-point or at a minimum of 2 ft above any sediment accumulated at the well bottom.

(2) The well screen volume will be based on a 5-foot screen length, $V_s=p*(D/2)^2*(5*12)*(2.54)^3$

(3) The drawdown from the initial water level should not exceed 0.3 ft.

(4) Purging will continue until stabilization is achieved or until 20 well screen volumes have been purged (unless purge water remains visually turbid and appears to be clearing, or unless stabilization parameters are varying slightly outside of the stablization criteria and appear to be stablizing), No. of Well Screen Volumes Purged= Vp/Vs.

SAMPLE COLLECTION FORM

1. **Sample ID:** ______________________________

2. **Sample Location:** ______________________________

3. **Sample Depth (ft BGS):** ______________________________

4. **Sample Date/Time:** ______________________________

5. **Matrix(circle one):** a) GW b) SW c) SED d) SO

6. **AUS:** ______________________________

7. **Number of sample containers:**

8. **Sampler:** ______________________________

9. **Chain-of-Custody #:** ______________________________

10. **Sample Type(circle one):** a) Normal b) Duplicate c) RinseBlank
d) FieldBlank e) TripBlank
f) MS g) MSD

If duplicate, list parent sample ID: ______________________________

11. **Sample Collection Method(circle one):** a) Grab b) Vertical Comp
c) Boring Cuttings d) GW-Bailer e) GW-LowFlowPump
f) Horizontal Comp g) DPT/Split Spoon h) Shelby Tube
i) Sediment Core j) Other

12. a) **If soil matrix(circle one):** a) Soil boring b) Core
c) Hand Auger d) Trowel

b) **Was soil excavated from site?:** Y or N

13. **Field Measurements:**

pH(s.u.) ______________ Conductivity (umhos/cm) ______________

Temp(Deg C) ______________ ORP(millivolts) ______________

DO(mg/L) ______________ Turb(NTU) ______________

WATER LEVEL RECORDS

PROJECT NAME: ____________________ LOCATION: ____________________

JOB NO. : ____________________ DATE: ____________________

CLIENT: ____________________ ENGINEER/GEOLOGIST: ____________________

OBSERVATION WELL	TOP OF CASING ELEVATION A		DEPTH TO WATER B		WATER LEVEL ELEVATION A-B	
	feet	metres	feet	metres	feet	metres

CRA

1001 (29) Rev. 12, September 13, 1999, Form SP-14

SURVEYOR DATA SHEET

Sample Location: ______________________________

Survey Date: ______________________________

1. **Horizontal** Survey Date: ____________________

a) X (UTM NAD83) ______________ Y (UTM NAD83) ____________________

State projection and datum if not UTM NAD8 ______________________________

b) **Horizontal Method of Collection(circle one)**

		Land surveyor	GPS-standard SA off
GPS-kinematic	GPS-static	GPS-differential	GPS-standard SA on

2. **Vertical:**

a) Z (NAVD 1988) ______________________________

State projection and datum if not NAVD 1988 ______________________________

b) **Vertical Method of Collection(circle one):**

		Land surveyor	GPS-standard SA off
GPS-kinematic	GPS-static	GPS-differential	GPS-standard SA on
		Leveling between non bench mark control points	

PROPERTY ACCESS/UTILITY CLEARANCE DATA SHEET

(QSF-019)

PROJECT NAME: ______________________ PROJECT NUMBER: ____________

CRA REPRESENTATIVE: ______________________

CLIENT: ____________ CLIENT REPRESENTATIVE: ____________ PHONE: ____________

ON-SITE PROPERTY ACCESS APPROVAL ____________ (OWNER OR AUTHORIZED AGENT SIGNATURE)

OFF-SITE PROPERTY ACCESS APPROVAL (if applicable) ____________ (OWNER OR AUTHORIZED AGENT SIGNATURE)

UTILITY CLEARANCE APPROVAL ____________ (OWNER OR AUTHORIZED AGENT SIGNATURE)

CONTRACTOR VERIFICATION APPROVAL ____________ (OWNER OR AUTHORIZED AGENT SIGNATURE)

UTILITIES (INDICATE THAT LOCATION/UTILITY PRESENCE WAS CHECKED) *												
Borehole/ Excavation Location	Date (m/d/y)	Telephone	Water	Storm Sewer	Sanitary Sewer	Process Sewer	Gas	Electrical	Cable	Overhead Utilities	Other	Comments/Warnings

Additional Comments:

____

____

____

White: Field Office
Yellow: Field File
Pink: Owner/Client/Agent

* Note as appropriate, Contractor, Client or Owner, or Agent to sign, indicating no utilities are at the selected borehole/excavation locations.

CRA 200016 QSF-019 Rev. 1 - 11/15/1999

THIS COMPLETED FORM IS A QUALITY RECORD

AUDIT CHECKLIST FOR GROUNDWATER SAMPLING

Project Name: ______________________ Field Team Leader: ______________________

Project No.: ______________________ Audit Date: ______________________

Sampling Personnel: ______________________ Audit No.: ______________________

Auditor Name: ______________________

Audit Question	*S*	*U*	*N/A*	*Comments*
Were all personnel briefed on their assignment?	☐	☐	☐	______________
Did the crew have all the forms and maps, equipment, and materials necessary to complete the assigned tasks?	☐	☐	☐	______________
Were the sampling locations correctly identified on the forms?	☐	☐	☐	______________
Were the field meters properly calibrated?	☐	☐	☐	______________
Were samples collected according to the procedure outlined in the FSP?	☐	☐	☐	______________
Were monitoring well locations properly marked?	☐	☐	☐	______________
Were the sampling equipment and meter probes properly cleaned between sample locations?	☐	☐	☐	______________
Were all sample containers properly labeled?	☐	☐	☐	______________
Were all sample containers properly filled? (e.g., no head space)?	☐	☐	☐	______________
Were all samples properly packed for shipping?	☐	☐	☐	______________
packed in ice?	☐	☐	☐	______________
custody seals in appropriate places?	☐	☐	☐	______________
Did personnel adhere to the safety procedure?	☐	☐	☐	______________

Additional Comments

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AUDIT CHECKLIST FOR MONITORING WELL INSTALLATION

Project Name: ____________________

Field Team Leader: ____________________

Project No.: ____________________

Audit Date: ____________________

Sampling Personnel: ____________________

Audit No.: ____________________

Auditor Name: ____________________

Audit Question	*S*	*U*	*N/A*	*Comments*
Were all personnel briefed on their assignment?	☐	☐	☐	
Did the crew have all the forms and maps, equipment, and materials necessary to complete the assigned tasks?	☐	☐	☐	
Was the drilling location neat and properly set up?	☐	☐	☐	
Were the field meters properly calibrated?	☐	☐	☐	
Were tasks completed according to the approved FSP?	☐	☐	☐	
Was drilling and sampling equipment properly deconned?	☐	☐	☐	
Was IDW properly handled?	☐	☐	☐	
Was the well location properly marked by the survey crew?	☐	☐	☐	
Did personnel adhere to the safety procedure?	☐	☐	☐	

Additional Comments

AUDIT CHECKLIST FOR SOIL SAMPLING

Project Name: ______________________

Project No.: ______________________

Sampling Personnel: ______________________

Auditor Name: ______________________

Field Team Leader: ______________________

Audit Date: ______________________

Audit No.: ______________________

Audit Question	*S*	*U*	*N/A*	*Comments*
Were all personnel briefed on their assignment?	☐	☐	☐	______________
Did the crew have all the forms and maps, equipment, and materials necessary to complete the assigned tasks?	☐	☐	☐	______________
Were the sampling locations correctly identified on the forms?	☐	☐	☐	______________
Were the field meters properly calibrated?	☐	☐	☐	______________
Were samples collected according to the procedure outlined in the FSP?	☐	☐	☐	______________
Was the depth of the soil samples consistent?	☐	☐	☐	______________
Were sample locations properly marked for the survey crew?	☐	☐	☐	______________
Were all sample containers properly labeled?	☐	☐	☐	______________
Were all sample containers properly filled? (e.g., no head space)?	☐	☐	☐	______________
Were all samples properly packed for shipping?	☐	☐	☐	______________
packed in ice?	☐	☐	☐	______________
custody seals in appropriate places?	☐	☐	☐	______________
Did personnel adhere to the safety procedure?	☐	☐	☐	______________

Additional Comments

____

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AUDIT FINDING REPORT

Project No.: ___________ Task No.: ___________ Audit No.: ___________ Audit Date: _______________

Individuals(s) contacted: ___________________________ Auditor Signature: __________________________________

Requirements: ____

____

Findings: ____

____

Recommended Corrective Action: ____

____

Scheduled Response Date:___________________________ Responsible for Corrective Action:______________________

Corrective Action Taken:____

Date: ___________________ Submitted BY: _______________________ Management Approval: ______________

Date Response Received: ___________________________ Response Acceptable? Yes No

Reason for Rejection: ____

Verification: ____

Date Verified: _________________________________ Auditor Signature: _______________________________________

APPENDIX C

SOIL AND GROUNDWATER FIELD DATA FORMS

QSF-251D	METER, WATER LEVEL
QSF-206D	OIL/WATER INTERFACE PROBE, KECK
QSF-295D	MONITOR, PID, MINIRAE 2000
QSF-247D	METER, TURBIDITY (PORTABLE), LAMOTTE 2020
QSF-238D	METER, PH/COND/TEMP, OAKTON
QSF-422D	METER, PH/COND/TEMP/DO/ORP/TDS/SALINITY/FLOW CELL, QED MP-20

FIELD DATA RECORD FORM
METER, WATER LEVEL

(QSF-251D)

Control No.: ______________________ **Project No.:** ______________________
Date: ______________________ **Project Name:** ______________________
User: ______________________ ______________________
Location: ______________________
Additional Equipment Control Numbers and Descriptions: ______________________

____

____

FIELD PROCEDURE BEFORE USE:

Check when completed

- Check for broken or missing parts.
- Check push button for operation of buzzer. ☐
- Check operation of signal light. ☐
- Try probe in water to see if unit operates, check rotary sensitivity switch if so equipped. ☐
- Check cable for cuts resulting in bare wire. ☐

Filing: Field File

Signature: ______________________

THIS COMPLETED FORM IS A QUALITY RECORD

Page __ of __

FIELD DATA: **(QSF-251D)**

Measurement No.	*Well No.*	*Date*	*Time*	*Reference Elevation (in m/ft)*	*Water Depth (in m/ft)*	*Water Elevation (in m/ft)*	*Comments*

Filing: Field File

Project No: ______________________ **Name (please print):** ______________________________

Date: ______________________ **Signature:** ______________________________

THIS COMPLETED FORM IS A QUALITY RECORD

FIELD DATA RECORD FORM
OIL/WATER INTERFACE PROBE, KECK

(QSF-206D)

Control No.: ____________________ **Project No.:** ____________________
Date: ____________________ **Project Name:** ____________________
User: ____________________ ____________________
Location: ____________________
Additional Equipment Control Numbers and Descriptions: ____________________

FIELD PROCEDURE BEFORE USE:

Check when completed

- Inspect unit for damage (reel, probe, tape, faceplate, and batteries). ☐
- Check carbon float for damage. ☐

Filing: Field File

Signature: ____________________

THIS COMPLETED FORM IS A QUALITY RECORD

Page __ of __

FIELD DATA: **(QSF-206D)**

No.	*Well No.*	*Location*	*Elevation Top of Well in*	*Oil Depth in*	*Elevation Top Oil in*	*Water Depth in*	*Elevation Water Oil in*	*Comments*

Filing: Field File

Project No: ______________________ **Name (please print):** ______________________________

Date: ______________________ **Signature:** ______________________________

FIELD DATA RECORD FORM
MONITOR, PID, MINIRAE 2000

(QSF-295D)

Control No.: ____________________ **Project No.:** ____________________
Date: ____________________ **Project Name:** ____________________
User: ____________________ ____________________
Location: ____________________
Additional Equipment Control Numbers and Descriptions: ____________________
____
____

FIELD PROCEDURE BEFORE USE:

Check when completed

- Gently unscrew the lamp housing cap.
- Remove the sensor adaptor with the gas inlet probe, and remove the metal and dust filters from the probe using tweezers.
- Check to ensure the probe is clean. ☐
- Replace the filters back into the probe cavity and replace the probe assembly.
- Turn the PID on by pressing the (Mode) key.
- During the warm-up period, check the pump inlet flow using your finger to detect suction. The warm-up ends when “Ready” is displayed. ☐
- Press the (Mode) key several times until the battery voltage is displayed.
- Check battery level and record on the space provided. Recharge if below 4.4 V. _____ V
- Press the (Mode) key several times until “Survey/Ready” is displayed.
- Press and hold both the (Mode) and the (N/-) keys for 3 seconds.
- At the prompt “Calibrate/select Gas?”, press the (Y/+) key.
  - If calibrating in unclean air, attach the charcoal filter to the PID probe. ☐
  - At the prompt “Fresh air cal?”, press the (Y/+) key to begin the zero calibration. The display will indicate “zero in progress” followed by a 15 second waiting period. At the end of the calibration, “zeroed!” will be displayed followed by the zero reading.
  - Ensure that the instrument is properly zeroed. ☐
  - Press any key to continue. Remove the charcoal filter from the PID probe.
- At the prompt “Fresh air cal?”, press the (N/-) key.
  - Place the regulator onto the calibration gas and connect to the PID probe. ☐
  - At the prompt “Span cal?”, press the (Y/+) key.
  - At the prompt “Apply gas now!”, quickly turn on the calibration gas valve. The calibration takes 30 seconds after which the display will indicate “cal’ed!” followed by the calibration reading.
  - Ensure that the calibration reading is +/- 2 ppm of the calibration gas value. ☐
  - Press any key to continue.
  - Turn off the valve of the calibration gas and disconnect from the PID.
- Press the (Mode) key several times until the “Ready” prompt is displayed.
- Press the (Y/+) key to start the measurement.
- To end the measurements, press the (Mode) key followed by the (Y/+) key.
- Press and hold the (Mode) key for 5 seconds to turn off the PID.

Filing: Field File

Signature: ____________________

FIELD DATA: **(QSF-295D)**

Sample No.	*Time*	*Location*	*Reading*	*Comments*

Filing: Field File

Project No: ______________________ **Name (please print):** ______________________________

Date: ______________________ **Signature:** ______________________________

THIS COMPLETED FORM IS A QUALITY RECORD

FIELD DATA RECORD FORM
METER, TURBIDITY (PORTABLE), LAMOTTE 2020

(QSF-247D)

Control No.: ____________________ **Project No.:** ____________________

Date: ____________________ **Project Name:** ____________________

User: ____________________ ____________________

Location: ____________________

Additional Equipment Control Numbers and Descriptions: ____________________

____

____

FIELD PROCEDURE BEFORE USE:

	Check when completed
• Check outside of reference standard bottles for cleanliness and condensation then wipe with lint free cloth.	☐
• Open lid and align arrows.	☐
• Insert the reference standard and index (10 or 1.0 NTU).	Standard Used: ______ NTU
• Press the READ button. (If the value displayed is not the same as the standard, continue the calibration procedure.)	☐
• Push the CAL button for 5 seconds until CAL is displayed.	
• Release the CAL button and the display will flash.	
• Press the up and /or down arrows until the value of the standard is displayed.	
• Push the CAL button again to store the calibration.	☐
• The instrument is now ready for use.	
• Turn the meter off by pressing the READ button for at least 1 second.	☐

Note: Condensation on outside of sample bottles affects meter readings.

Filing: Field File

Signature: ________________________________

Page __ of __

FIELD DATA: **(QSF-247D)**

Test No.	*Sample Location*	*Turbidity Reading (NTU)*	*Comments*

Filing: Field File

Project No: ______________________ **Name (please print):** ______________________

Date: ______________________ **Signature:** ______________________

THIS COMPLETED FORM IS A QUALITY RECORD

FIELD DATA RECORD FORM
METER, TURBIDITY (PORTABLE), LAMOTTE 2020

(QSF-247D)

Control No.: ____________________ **Project No.:** ____________________
Date: ____________________ **Project Name:** ____________________
User: ____________________ ____________________
Location: ____________________
Additional Equipment Control Numbers and Descriptions: ____________________

____
____

FIELD PROCEDURE BEFORE USE:

	Check when completed
• Check outside of reference standard bottles for cleanliness and condensation then wipe with lint free cloth.	☐
• Open lid and align arrows.	☐
• Insert the reference standard and index (10 or 1.0 NTU).	Standard Used: ______ NTU
• Press the READ button. (If the value displayed is not the same as the standard, continue the calibration procedure.)	☐
• Push the CAL button for 5 seconds until CAL is displayed.	
• Release the CAL button and the display will flash.	
• Press the up and /or down arrows until the value of the standard is displayed.	
• Push the CAL button again to store the calibration.	☐
• The instrument is now ready for use.	
• Turn the meter off by pressing the READ button for at least 1 second.	☐

Note: Condensation on outside of sample bottles affects meter readings.

Filing: Field File

Signature: ______________________________

Page __ of __

FIELD DATA: **(QSF-247D)**

Test No.	*Sample Location*	*Turbidity Reading (NTU)*	*Comments*

Filing: Field File

Project No: ______________________ **Name (please print):** ______________________________

Date: ______________________ **Signature:** ______________________________

THIS COMPLETED FORM IS A QUALITY RECORD

FIELD DATA RECORD FORM
METER, PH/COND./TEMP., OAKTON

(QSF-238D)

Control No.: ______________________ **Project No.:** ______________________
Date: ______________________ **Project Name:** ______________________
User: ______________________ ______________________
Location: ______________________
Additional Equipment Control Numbers and Descriptions: ______________________

____

____

FIELD PROCEDURE BEFORE USE:

CHECK KIT CONTENTS BEFORE USE.

Check when completed

pH Calibration:

- Press the MODE key to select pH mode.
- Dip the probe into the calibration buffer. ☐
- Press CAL/MEAS key to enter pH calibration mode. The larger display will show the measured reading while the smaller display will indicate the pH standard buffer. ☐
- If needed, use the up or down keys to change the secondary display.
- Wait for the measured pH value to stabilize, then press enter to confirm calibration. ☐
- Repeat the above Steps with the 4.0, 7.0, and/or 10.0 buffer solutions. ☐
- When finished, press CAL/MEAS to return to pH measurement mode. ☐

Conductivity Calibration:

- Immerse probe in calibration standard ☐
- Press the MODE key to select Conductivity Mode. ☐
- Wait for the reading to stabilize.
- Press the CAL/MEAS key. ☐
- Press the up or down arrow keys to scroll to the value of your conductivity standard.
- Press center to confirm calibration. ☐
- Repeat calibration steps with at least one other standard. ☐
- Complete temperature calibration by referring to the instruction manual. ☐

Filing: Field File

Signature: ______________________________

THIS COMPLETED FORM IS A QUALITY RECORD

Page __ of __

FIELD DATA: **(QSF-238D)**

Test No.	***Sample Location***	***pH in Standard Units***	***Conductivity (in mS/cm or μS/cm)***	***Temperature (in °C)***	***Comments***

Filing: Field File

Project No: ______________________ **Name (please print):** ______________________________

Date: ______________________ **Signature:** ______________________________

THIS COMPLETED FORM IS A QUALITY RECORD

FIELD DATA RECORD FORM (QSF-422D)
METER, PH/COND./TEMP./DO/ORP/TDS/SALINITY/FLOW CELL, QED MP-20

Control No.: ____________________ **Project No.:** ____________________
Date: ____________________ **Project Name:** ____________________
User: ____________________ ____________________
Location: ____________________
Additional Equipment Control Numbers and Descriptions: ____________________

____

____

FIELD PROCEDURE BEFORE USE:

	Check when completed
• Check kit contents.	☐
• Check battery level. Change if at or less than 3 volts.	
• Check pH 7 buffer reading. Calibrate if greater than ±0.2.	Reading _______
PH is a two point calibration but always start with the seven standard.	
• Fill calibration cup ½ full with pH 7.0 buffer and attach to probe with probes facing down.	Calibrated Y / N
• Use ← key to start the calib symbol to flashing and press enter ↵.	
• Use ↓ key to start pH symbol to start flashing and press enter ↵.	
• Use ↑or ↓ to raise or lower displayed value to match the standard then press enter ↵.	
• Fill calibration cup ½ full with pH 4 or 10 buffer and attach to probe with probes facing down.	
• Repeat steps 3 and 4.	
• Press Esc to return to the real time data screen.	
Check conductivity standard near the expected range. Calibrate if greater than ±0.5%.	Standard _______ Reading _______
Conductivity is a one point calibration.	Calibrated Y / N
• Fill calibration cup ½ full with 0.7 mS standard and attach to probe with probes facing up.	
• Use ← key to start the calib symbol to flashing and press enter ↵.	
• Use ↓ key to start SpC symbol to start flashing and press enter ↵.	
• Use ↑or ↓ to raise or lower displayed value to match the standard then press enter ↵.	
• Press Esc to return to the real time data screen.	
Check DO-probe for air bubbles and change membrane and solution if needed (see manual for instructions).	

Filing: Field File

Signature: ______________________________

THIS COMPLETED FORM IS A QUALITY RECORD

FIELD DATA: **(QSF-422D)**

Test No.	*Sample Location*	*pH*	*Conductivity (in mS/cm or µS/cm)*	*Temperature (in °C)*	*DO (in mg/L)*	*Comments*

Filing: Field File

Project No: ______________________

Name (please print): ______________________

Date: ______________________

Signature: ______________________

THIS COMPLETED FORM IS A QUALITY RECORD

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QUALITY ASSURANCE PROJECT PLAN
ADDITIONAL AND UNCHARACTERIZED SITES OPERABLE UNIT
CRAB ORCHARD NWR
MARION, ILLINOIS WILLIAMSON COUNTY

FINAL
February, 2006

Prepared by: NewFields Companies L.L.C., ENTRIX, Inc., & Conestoga-Rovers & Associates

Prepared for: U.S. EPA, Region 5, Superfund Division - Chicago, IL

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Approved By: ______________________ NewFields Companies L.L.C. QA Manager	4/17/06 Date
Approved By: ______________________ ENTRIX, Inc. Project Manager	4/13/06 Date
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Approved By: ______________________ Conestoga-Rovers & Associates Project Manager	04/13/06 Date
Approved By: ______________________ Illinois EPA Project Coordinator	4/18/06 Date
Approved By: Nan Gowda USEPA Region 5 Project Coordinator	4/20/06 Date
Approved By: Richard L Byvik USEPA Region 5 Quality Assurance Reviewer	2/3/06 Date
Approved By: E. Leanne Moore U.S. Fish & Wildlife Service Project Coordinator/Remedial Project Manager	4/18/06 Date
Approved By: ______________________ U.S. Fish & Wildlife Service Quality Assurance Reviewer	4/18/06 Date

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Prepared by: NewFields Companies L.L.C., ENTRIX, Inc., & Conestoga-Rovers & Associates

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EcoChem, Inc. Project Manager Date

Approved By: 4/13/06
Pacific Agricultural Laboratory Project Manager Date

QUALITY ASSURANCE PROJECT PLAN
ADDITIONAL AND UNCHARACTERIZED SITES OPERABLE UNIT
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MARION, ILLINOIS WILLIAMSON COUNTY

FINAL

April, 2006

Prepared by: NewFields Companies L.L.C., ENTRIX, Inc., & Conestoga-Rovers & Associates

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LIST OF APPENDICES

LIST OF ACRONYMS/ABBREVIATIONS

AOC	Administrative Order on Consent
AUS OU	Additional and Uncharacterized Sites Operable Unit
BRA	Baseline Risk Assessment
C	Celsius
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CF	Calibration Factor
CERCLA	Comprehensive Environmental Response, Conservation, and Liability Act
CLP	Contract Laboratory Program
COC	Chain-of-Custody
COPEC	Constituents of Potential Ecological Concern
CRA	Conestoga-Rovers & Associates
CSM	Conceptual Site Model
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DOI	Department of the Interior
DPT	Direct-push technology
DQO	Data Quality Objective
EcoChem	EcoChem, Inc.
EDD	Electronic Data Deliverable
EPF	Ecological Problem Formulation
ERA	Ecological Risk Assessment
FS	Feasibility Study
FSP	Field Sampling Plan
FWS	United States Fish and Wildlife Service
GC	Gas Chromatography
GC/EC	Gas Chromatograph using Electron Capture
GC/FPD	Gas Chromatograph/Flame Photometric Detector
GC/MS	Gas Chromatograph/Mass Spectrometer
GD-OTS	General Dynamics Ordnance and Tactical System, Inc.
HCL	Hydrochloric Acid
HPLC	High Performance Liquid Chromatography
HSA	Hollow Stem Auger
ICP	Inductively Coupled Plasma
ICV	Initial Calibration Verification
IEPA	Illinois Environmental Protection Agency
IOP	Illinois Ordnance Plant
LCS	Laboratory Control Standard
LC/MS	Liquid Chromatography/Mass Spectrophotometry

LIST OF ACRONYMS/ABBREVIATIONS

LCS/LCSD	Laboratory Control Spike/Laboratory Control Spike Duplicate
LFP	Low-Flow Procedures
mL	milliliter
MS	Matrix Spike
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NewFields	NewFields Companies, L.L.C.
NIST	National Institute of Standards and Technology
NPL	National Priorities List
ORP	Oxidation/Reduction Potential
OU	Operable Units
PAH	Polynuclear Aromatic Hydrocarbon
PAL	Pacific Agricultural Laboratory
PA/SI	Preliminary Assessment/Site Inspection
PCB	Polychlorinated Biphenyl
PETN	Pentaerythritoltetranitrate
PID	Photo Ionization Detector
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
Refuge	Crab Orchard Wildlife Refuge National Priorities List Site
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSD	Relative Standard Deviation
RT	Retention Time
SDG	Sample Delivery Group
SIM	Selective Ion Monitoring
SMC	System Monitoring Compound
SOP	Standard Operating Procedure
SOW	Statement of Work
SRM	Standard Reference Materials
STL	Severn Trent Laboratories
SVOC	Semi-Volatile Organic Compound
TACO	Tiered Approach to Corrective Action Objectives
TAL	Target Analyte List
TCL	Target Compound List
TDS	Total Dissolved Solids
TNT	2,4,6-trinitrotoluene
TOC	Total Organic Carbon

LIST OF ACRONYMS/ABBREVIATIONS

TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
YSI	Yellow Springs Incorporated
%R	Percent Recovery
%RSD	Percent Relative Standard Deviation

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

NewFields Companies L.L.C. (NewFields), on behalf of General Dynamics Ordnance and Tactical System, Inc. (GD-OTS) is submitting a Remedial Investigation/Feasibility Study (RI/FS) Work Plan (referenced in this document as the "RI/FS Work Plan") in accordance with the Administrative Order on Consent (AOC) document. Conestoga-Rovers and Associates (CRA) and ENTRIX, Inc. (ENTRIX) wrote the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP) and contributed to the development of the RI/FS Work Plan. This document was developed to address specific investigations at the Crab Orchard Wildlife Refuge National Priorities List (NPL) Site ("Refuge") in Marion, Illinois. Specifically, the RI/FS Work Plan addresses proposed actions at Additional and Uncharacterized Sites Operable Unit (AUS OU) of the Refuge. Refer to the figure(s) in Section 2 of the RI/FS Work Plan that indicate the location of the 32 sites that comprise the AUS OU under investigation.

This QAPP has been written to satisfy requirements outlined in the AOC and is a complimentary document to the RI/FS Work Plan and the FSP. This QAPP and FSP comprise Volume 2 of the RI/FS Work Plan.

The United States Environmental Protection Agency (USEPA) policy requires that all work performed by or on behalf of the USEPA involving the collection of environmental data be implemented in accordance with a USEPA-approved QAPP. The QAPP is a planning document that provides a "blueprint" for obtaining the type and quantity of data needed to support environmental decision making. The QAPP integrates all technical and quality aspects of a project and documents all quality assurance (QA), quality control (QC), and technical activities and procedures associated with planning, implementing, and assessing environmental data collection operations.

This QAPP has been prepared in accordance with the "USEPA-Region 5 Instructions on the Preparation of a Superfund Division Quality Assurance Project Plan, Revision 0", June 2000. In accordance with this document, there are four basic groups of elements that must be included in a QAPP. These four groups and associated elements are:

- Group A – Project Management. The elements in this group include all aspects of project management, project objectives, and project history;

- Group B – Data Generation and Acquisition. The elements in this group include descriptions of the design and implementation of all measurement systems that will be used during the project;
- Group C – Assessment/Oversight. The elements in this group encompass the procedures used to ensure proper implementation of the QAPP; and
- Group D – Data Validation and Usability. The elements of this group cover the QA activities that occur after the data collection phase of the project is completed.

The elements that comprise project management, data generation and acquisition, assessment/oversight, and data validation and usability for the Remedial Investigation (RI) to be conducted at the AUS sites are documented in this QAPP.

1.2 REFUGE DESCRIPTION

The Refuge is located approximately 5 miles west of the City of Marion in Williamson, Jackson, and Union Counties in southern Illinois. It includes 43,500 acres of forests, grassland areas, cropland, wetlands, and industrial areas.

A portion of the area now occupied by the Refuge was the Illinois Ordnance Plant (IOP) during World War II. The IOP was managed by the War Department, a predecessor to the current Department of Defense. From 1942 to 1945, the Sherwin Williams Defense Corporation operated the IOP under contract with the War Department for the manufacture of military ordnance. The IOP occupied some 22,000 acres and contained some 534 buildings and various utilities, including steam generating, water, sewage and wastewater treatment facilities and a railroad line. IOP operations consisted of seven load lines: three were 2,4,6-trinitrotoluene (TNT) melt-pour operations for shells, bombs and mines; the other four were for boosters, detonators, primers and fuses for the shells, bombs and mines.

On VJ Day, September 2, 1945, operations ceased and the IOP was transferred to the War Assets Administration for disposition. In 1947 an Act of Congress transferred the old IOP area, together with an additional 21,500 acres, to the Department of the Interior (DOI), thereby creating the Crab Orchard National Wildlife Refuge. The enabling legislation assigned DOI the responsibility of managing the area as a wildlife refuge, with the additional mission of supporting recreation, agriculture and industrial use.

Over the years, some 200 tenants have operated manufacturing and/or storage facilities under lease to the DOI United States Fish and Wildlife Service (FWS) at the Refuge. Many of these have been small businesses or short-term tenants. Larger and/or longer term tenants have included manufacturers of ordnance and explosives, electrical components, inks and printing materials, machined and plated metal parts, various painted products and boats. Over time, the principal tenant has been the Olin Corporation (formerly Olin Mathieson Chemical Corporation) and its successors, Primex Technologies, Inc., now GD-OTS, which has operated ordnance/explosives manufacturing and storage facilities in several industrial areas on the Refuge since 1956.

1.3 PAST DATA COLLECTION ACTIVITIES

There have been investigations of other Comprehensive Environmental Response, Conservation, and Liability Act (CERCLA) operable units (OUs) at the Refuge. Some of these OUs are still active; some have been closed. Those OUs aren't discussed in this document because any relevant similarities between QA in those investigations will be addressed by adherence to USEPA Region V QAPP guidance.

The DOI formed the AUS OU in 1997 to address potential releases of hazardous substances in 83 sites that weren't completely covered by the other OUs at the Refuge. Between 1997 and 2001 a Preliminary Assessment/Site Inspection (PA/SI) for AUS OU was conducted by the FWS. The results of that investigation were summarized in the Final PA/SI Report dated June 2003 (FWS, 2003a).

The PA/SI concluded that 32 of the sites in the AUS OU required an RI. The PA/SI also included screening ecological and human health risk assessments. These screening risk assessments identified Constituents of Potential Ecological Concern (COPECs) and human health Constituents of Potential Concern, respectively.

For a comprehensive discussion of past data collection activities, refer to the RI/FS Work Plan.

1.4 CURRENT STATUS

Following the PA/SI, the FWS completed a Draft Ecological Problem Formulation (EPF) dated March 2003 (FWS, 2003b) which is incorporated into the

RI/FS Workplan by reference. The EPF included a COPEC refinement process and a Conceptual Site Model (CSM) for each AUS. Assessment and Measurement Endpoints were also identified in the EPF; and ecological receptors were named for each AUS.

This RI will continue the investigation of the AUS OU by building on the work completed..

A summary of the data needed to complete the RI/FS for the AUS OU is provided in Table 1.1.

1.5 PROJECT OBJECTIVES

Project Objectives are discussed in Section 4.0 of the RI/FS Work Plan.

1.5.1 PROJECT TARGET PARAMETERS AND INTENDED DATA USAGE

The target parameters and laboratory reporting limits for this project are included in Tables 1.3 through 1.21. Various limits are subject to change within the analytical laboratory. Although method detection limits may change over the course of the project, amendments to the QAPP are not required to reflect these changes. Table 1.2 summarizes the laboratory methods and field monitoring that will be conducted per sample matrix.

Following the collection of data, baseline risk assessments (BRAs) will be performed by FWS. Because of the incomplete knowledge of the AUS site and the iterative nature of the RI, additional data requirements and analyses may be identified throughout the RI/FS process. These data will eventually be compared to the ecological benchmarks and human health screening values provided in the RI/FS Work Plan. These tables are located in Section 5 of the RI/FS Work Plan. Ecological benchmarks are also provided in Tables 1.5 through Table 1.21 of this QAPP.

1.5.2 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The seven step Data Quality Objectives (DQOs) process, as described in Guidance for the Data Quality Objectives Process (USEPA QA/G4) and Data

Quality Objectives Process for Superfund: Interim Final Guidance (USEPA, 1993) was used as the framework for designing this RI/FS for the AUS OU. The conceptual approach that was developed for the RI and subsequent site management strategy is consistent with the DQO process, in that both procedures specifically identify the decisions to be made and develop a sampling plan that will provide the required information.

DQOs are described in Section 4.0 of the RI/FS Workplan.

1.6 SAMPLE NETWORK DESIGN & RATIONALE

A complete description of the sample network design and rationale is provided in Section 4 of the RI/FS Work Plan.

1.7 SAMPLE NETWORK BY TASK AND MATRIX

Sample matrices, analytical parameters and frequencies of sample collection for investigation sampling can be found in Table 1.2.

1.7.1 FIGURES OF SAMPLING LOCATIONS

Figures showing intended sampling locations are included in Section 5 of the RI/FS Work Plan.

1.8 PROJECT SCHEDULE

A project schedule for RI/FS activities has been developed in accordance with the Statement of Work (SOW). The project schedule is presented as Figure 14.1 of the RI/FS Work Plan.

1.8.1 ANTICIPATED DATE OF PROJECT MOBILIZATION

An anticipated project schedule for RI/FS activities has been developed in accordance with the SOW. The anticipated project schedule, which is presented as Figure 14.1 of the RI/FS Work Plan, outlines the anticipated date of project mobilization.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

GD-OTS through their law firm, Jenner and Block, retained NewFields in May 2002 to serve as Owner's Agent/Program Manager in the negotiation of the AOC and management of the RI/FS. GD-OTS also retained ENTRIX to provide ecological risk assessment support work for the RI/FS, CRA to conduct field services (drilling, data collection, unexploded ordnance clearance, and surveying), Severn Trent Laboratories (STL) and Pacific Agricultural Laboratory (PAL) for chemical analysis, and Ecochem, Inc to provide the third-party validation The various QA and management responsibilities of key project personnel are defined below.

2.1 PROJECT ORGANIZATION CHART

The project organization chart for this project can be found as Figure 2.1 of this QAPP. This chart includes all individuals discussed below.

2.2 MANAGEMENT RESPONSIBILITIES

United States Environmental Protection Agency Project Coordinator--Nan Gowda

The USEPA Project Coordinator represents the USEPA and is responsible for ensuring that USEPA guidance and policy is followed and that USEPA objectives are achieved.

Illinois Environmental Protection Agency Project Coordinator--Paul Lake

Illinois Environmental Protection Agency (IEPA) is designated as the implementing agency within the State of Illinois for purposes of CERCLA and is authorized to act on behalf of the State. The IEPA Project Coordinator assists in directing the project and is responsible for ensuring that all state guidelines are followed and all state objectives are achieved, and is responsible for overseeing implementation of the work required under the AOC for the IEPA.

United States Fish and Wildlife Service Project Coordinator/Remedial Project Manager (RPM)--Leanne Moore

The FWS is the lead agency for the AUS OU, under the CERCLA Section 104 authority delegated to the FWS, as described in the AOC. The FWS assumes the overall management of this investigation on behalf of the federal government. The FSW project coordinator/RPM directs the project and is responsible for ensuring that the work is done in accordance with the requirements of the AOC, and is responsible for overseeing implementation of the work required under the AOC for the FWS.

Project Coordinator on Behalf of GD-OTS –William Hall

The Chief Executive Officer of NewFields serves at the project coordinator for this effort and is responsible for the overall management of the RI/FS. As NewFields' Chief Executive Officer, Mr. Hall is responsible for the following quality-related functions:

- States and issues the NewFields' QA policy and requires Crab Orchard team adherence to the Quality Management Plan (NewFields, 2003);
- Interprets and directs the accomplishment of the Quality Management Plan objectives, plans and policies;
- Appoints the quality and project managers.

Project Manager on Behalf of GD-OTS – Dave Trainor

The NewFields Project Manager has overall responsibility for ensuring that the project meets the USEPA's, the IEPA's, and the FWS's objectives and the consultant's quality standards. The NewFields Project Manager will provide assistance in terms of revising and distributing the RI/FS Work Plan, QAPP and FSP to all those parties connected with the project. The NewFields Project Manager is responsible for technical QC and project oversight. Specifically, the NewFields Project Manager has responsibility for supporting the project coordinator on behalf of GD-OTS in the overall management and execution of the RI/FS.

NewFields Human Health Risk Assessor – Kathy Wurzel

Ms. Wurzel will participate in the human health work group and will be responsible for ensuring that the FWS human health risk assessment results are incorporated into the RI/FS.

NewFields Technical Staff

NewFields Technical Staff will assist the Project Coordinator, Project Manager and Human Health Risk Assessor with tasks related to NewField's scope of work. These technical staff will assist with the distribution of work plans and summary reports, managing the project database and geographic information system, and execution of the RI/FS.

ENTRIX, Inc. Project Manager – Todd Williams

The ENTRIX Project Manager has responsibility for ensuring that the project meets the USEPA's, the IEPA's, and the FWS's objectives and the consultant's quality standards. The ENTRIX Project Manager will provide assistance in terms of revising and distributing the RI/FS Work Plan, QAPP and FSP to all parties connected with the project. Specifically the ENTRIX Project Manager has responsibility for overseeing the collection of surface water and sediment samples and for acting as GD-OTS representative in coordinating the integration of FWS' ERA with the rest of the RI/FS.

Conestoga-Rovers & Associates Project Manager – Steve Wanner

The CRA Project Manager has responsibility for ensuring that the project meets the USEPA's, the IEPA's, and the FWS's objectives and the consultant's quality standards. The CRA Project Manager will provide assistance in terms of revising and distributing the RI/FS Work Plan, QAPP and FSP to all those parties connected with the project. The CRA Project Manager is responsible for technical QC and project oversight. Specifically, the CRA Project Manager has responsibility for managing the sampling of soil and groundwater and managing survey activities.

2.3 QA RESPONSIBILITIES

QA Managers – Cheryl Randle (ENTRIX) Charlene Rivard (NewFields)

The QA Managers will be responsible for ensuring that all QA/QC procedures for this project are being followed. The QA Managers will review and approve the QAPP. The QA Managers will monitor sample techniques and collection, will address any corrective action or issue that may arise with the analytical laboratory and will oversee the data validation process of all sample results from the analytical laboratory. The QA Managers will also perform internal and external performance and system audits. The audit process will include but not be limited to auditing field sampling techniques, and auditing the analytical laboratory and data validation firm. The United States Environmental Protection Agency –Region 5 Quality Assurance Reviewer will assure that the QA/QC procedures for this project are being followed on behalf of the USEPA.

2.4 FIELD RESPONSIBILITIES

Conestoga-Rovers & Associates Field Supervisor – Walt Pochron

The CRA Project Manager will be supported by the CRA Field Supervisor. He is responsible for leading and coordinating the day-to-day activities of the various resource specialists under his supervision with specific regard to the collection of groundwater and soil samples. The CRA Field Supervisor will report directly to the CRA Project Manager. Specific Field Supervisor responsibilities include the following:

- Responsible for the day-to-day coordination with the CRA Project Manager on technical issues in specific areas of expertise;
- Developing and implementing field-related Work Plans, assurance of schedule compliance, and adherence to management-developed study requirements;
- Coordinating and managing of field staff including sampling and drilling;
- Acting as field sample custodian;
- Implementing of QC for technical data provided by the field staff including field measurement data;
- Adhering to work schedules provided by the CRA Project Manager;
- Authoring, writing, and approving of text and graphics required for field team efforts;
- Coordinating and overseeing technical efforts of subcontractors assisting the field team;
- Identifying problems at the field team level, resolving difficulties in consultation with the CRA Project Manager, implementing and documenting corrective action procedures, and provision of communication between team and upper management; and

- Participating in preparation of the final report.

Conestoga-Rovers & Associates Field Technical Staff

The CRA technical staff (team members) for this project will be drawn from CRA's pool of corporate resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

ENTRIX Field Supervisor – BJ Seagrist

The ENTRIX Project Manager will be supported by the ENTRIX Field Supervisor. He is responsible for leading and coordinating the day-to-day activities of the various resource specialists under his supervision with specific regard to the collection of surface water and sediment. The ENTRIX Field Supervisor will report directly to the ENTRIX Project Manager. Specific Field Supervisor responsibilities include the following:

- Responsible for the day-to-day coordination with the ENTRIX Project Manager on technical issues in specific areas of expertise;
- Developing and implementing of field-related Work Plans, assurance of schedule compliance, and adherence to management-developed study requirements;
- Coordinating and managing of field sampling staff;
- Acting as field sample custodian;
- Implementing of QC for technical data provided by the field staff including field measurement data;
- Adhering to work schedules provided by the ENTRIX Project Manager;
- Authoring, writing, and approving of text and graphics required for field team efforts;
- Coordinating and overseeing technical efforts of subcontractors assisting the field team;
- Identifying problems at the field team level, resolving difficulties in consultation with the project manager, implementing and documenting

corrective action procedures, and provision of communication between team and upper management; and

- Participating in preparation of the final report.

ENTRIX Consulting Field Technical Staff

The ENTRIX technical staff (team members) for this project will be drawn from ENTRIX's pool of corporate resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

2.5 LABORATORY RESPONSIBILITIES

STL has been selected as the analytical laboratory for this project. STL North Canton (North Canton, OH) will be the primary laboratory to support the project. STL Sacramento (Sacramento, CA) will provide specialty analytical services for perchlorate and explosives analyses, and STL Burlington (Burlington, VT) will provide support for analysis of geotechnical parameters. Pacific Agricultural Laboratory (PAL) will be utilized for the organophosphorus pesticide analyses. The analytical method list and matrices that will be analyzed for this project are located in Table 1.2.

Severn Trent Laboratories Corporate Advocate – Joe Walker

The STL Corporate Advocate will communicate directly with the ENTRIX Project Manager and will be responsible for the following:

- Perform a facilitating role to ensure project coordination between STL laboratories; and
- Efficient delivery of the daily services and support necessary to accommodate the analytical demands of this project.

Severn Trent Laboratories Project Manager – Ken Kuzior

The STL Project Manager will be responsible for the following:

- Project coordination between STL's network of laboratories for this investigation;
- Coordinating laboratory analyses;
- Supervising in-house chain-of-custody (COC);
- Scheduling sample analyses;
- Overseeing data review and completeness;
- Overseeing preparation of analytical reports; and
- Approving final analytical reports prior to distribution.

Severn Trent Laboratories, Inc./STL North Canton QA Officer – Dorothy Leeson
Severn Trent Laboratories, Inc./STL Sacramento QA Officer – Kirstin McKracken
Severn Trent Laboratories, Inc./STL Burlington QA Officer – Pamela Schemmer

The STL QA Officers will be independent of their respective laboratories but will communicate data issues through the STL Project Manager. In addition, the STL QA Officers will be responsible for the following:

- Overview laboratory QA;
- Overview QA/QC documentation;

- Determine whether to implement laboratory corrective actions, if required;
- Conduct detailed data review, if corrective action warrants;
- Define appropriate laboratory QA procedures; and
- Prepare laboratory Standard Operating Procedures (SOPs).

Severn Trent Laboratories Sample Custodian – John McFadden

Responsibilities of the STL Sample Custodian will include:

- Receiving and inspecting the incoming sample containers;
- Recording the condition of the incoming sample containers;
- Signing appropriate documents;
- Verifying COC and its correctness;
- Notifying laboratory manager and laboratory supervisor of sample receipt and inspection;

- Assigning a unique identification number and customer number, and entering each into the sample receiving log;
- Facilitating sample transfer to analysts who are retrieving and documenting their removal for use in analysis. The sample custodian is also in charge of restocking the sample after they are returned by the analysts, and documents its arrival to keep a record of custody.
- Controlling and monitoring access/storage of samples and extracts.

Severn Trent Laboratories Technical Staff

The STL Technical Staff will be responsible for sample analysis and identification of corrective actions. The laboratory has a Level I/II review process where the analyst reviews the initial data, followed by a Level II review from a senior analyst. The Project Manager reviews for completeness. The QA Officer will handle any corrective action necessary.

2.6 THIRD-PARTY VALIDATION

EcoChem, Inc. (EcoChem) has been selected to perform third-party validation of the analytical data generated for this project. The intent of data validation and information management is to ensure that project data will be accepted by multiple data users (agency and private) with differing needs and requirements, while maintaining data integrity and accessibility.

EcoChem Vice President/Project Advisor – Linda Bohannon

As the director of EcoChem's Chemistry and QA Group, Ms. Bohannon oversees data validation and chemistry quality assessment projects and ensures that each client receives deliverables and technical expertise, which meet their specific requirements. She also serves as EcoChem's Corporate QA Officer.

EcoChem Project Manager/Technical Director – Eric Strout

As Project Manager for this project, Mr. Strout's responsibilities include primary contact with ENTRIX; project status and resource management; preparation of final deliverables (both paper and database); senior technical review; resolution of technical issues; response to comments from ENTRIX; chemistry consult and assistance with preparation of project quality documents; and analytical method interpretation. He will rely on the Organic and Inorganic Task Managers to lead the data validation efforts and to convey detailed status, both schedule and budget, of current work.

Inorganic Task Manager/EcoChem Sr. Project Chemist - Chris Ransom

As the Inorganic Task Manager for this project, Ms. Ransom's responsibilities include scheduling and status of inorganic data validation; senior review of all inorganic method data validation; resolution of technical deficiencies; and final review of inorganic data validation reports.

Organic Task Manager/EcoChem Project Chemist - John Mitchell

As the Organic Task Manager for this project, Mr. Mitchell's responsibilities include scheduling and status of organic data validation; senior review of all organic method data validation; resolution of technical deficiencies; and final review of organic data validation reports.

EcoChem Project Coordinators and Technical Staff

EcoChem Project Coordinators and Technical Staff will be responsible for assisting the EcoChem Project Manager with the day-to-day data validation activities.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this project is to develop and implement procedures for field sampling, COC, laboratory analysis, and reporting that will provide results that are scientifically defensible. Specific procedures for sampling, COC, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventive maintenance of field equipment, and corrective action are described in the other sections of this QAPP.

3.1 PRECISION

3.1.1 DEFINITION

Precision is the degree of agreement among repeated measurements of the same characteristic (analyte, parameter, etc.) under the same or similar conditions (USEPA, 2000).

3.1.2 FIELD PRECISION OBJECTIVES

Field precision is assessed through the collection and measurement of field duplicates at a rate of one duplicate per 20 analytical samples (Table 1.2) or, at a minimum, one per AUS site. Duplicate field measures will be collected at a 10 percent frequency for dissolved oxygen (DO), pH, temperature, oxidation/reduction potential (ORP) and conductivity. These analyses measure both field and Laboratory precision. The results, therefore, may have more variability than Laboratory duplicates that measure only Laboratory performance. It is also expected that soil duplicate results will have a greater variance than water matrices due to difficulties associated with collecting identical field samples.

Precision will be assessed through the calculation of the relative percent difference (RPD) for two replicate samples and relative standard deviation (RSD) for three or more replicate samples. RPD is calculated according to the following formula (USEPA, 2000):

$$RPD = \frac{S - D}{(S + D) / 2} X\ 100$$

Where: S = Original sample value;
D = Duplicate sample value.

The acceptance criteria for RPD will be less than or equal to 20%.

Percent RSD is calculated according to the following formula (USEPA, 1986b):

$$\%RSD = \frac{Standard\ Deviation}{Mean} X\ 100$$

Due to the inherent variability in screening of volatile organic compounds (VOCs) by a photo-ionization detector (PID), duplicate measures will not be meaningful. Further, the purpose of a PID is merely a screening tool (qualitative) and not to provide quantitative data that will later be assessed for trends.

3.1.3 LABORATORY PRECISION OBJECTIVES

Precision in the laboratory is also assessed through RSDs (for three or more replicate samples) and the calculation of RPDs. The collection and use of these replicate samples is discussed in Section 12.1. RPDs of 35 percent and 50 percent for water and soil/sediment sample field duplicates, respectively, will be used as advisory limits for analytes detected in both the investigative and field duplicate samples at concentrations greater than or equal to five times its quantitation limit. The equations to be used for precision in this project can be found in Section 12 of this QAPP. Precision control limits are included in the STL SOPs found in Appendix A of this QAPP.

3.2 ACCURACY

3.2.1 DEFINITION

Accuracy is the extent of agreement between an observed value (sample results) and the accepted, or true, value of the parameter being measured (USEPA, 2000).

3.2.2 FIELD ACCURACY OBJECTIVES

Accuracy of the field sample collection procedures ensures that samples are not affected by sources external to the sample, such as sample contamination by ambient conditions or inadequate equipment decontamination procedures. Field sampling accuracy will be assessed by the data from equipment and trip blank samples.

Equipment blank samples will be collected at a frequency of one per 20 or fewer sampling equipment decontamination procedures. Equipment blank samples, collected by routing laboratory-provided deionized water (for inorganic analyses), or organic-free water (for organic analyses) through decontaminated sampling equipment, will be analyzed to check procedural contamination and/or ambient conditions and/or sample container contamination at the AUS site that may cause sample contamination. If sampling equipment is being decontaminated based on organic contamination, then organic free water will be used as the final rinse for purposes of collecting the blank sample. Deionized water will be used if metals contamination is suspected.

Trip blank samples, consisting of organic-free water poured into VOC sample vials at the laboratory under contaminant-free conditions, will be provided by STL for the surface water and groundwater sampling events. Trip blank samples will be handled in a manner consistent with actual field samples, but will not be opened and will be shipped back to the laboratory with the samples. Trip blank samples will provide a measure of potential cross-contamination of samples by VOCs during shipment and handling. Two trip blank samples will only be included in each shipping cooler that contains multiple aqueous samples that will be submitted for VOC analysis.

Equipment and trip blank samples should not contain target analytes. The equipment and trip blank sample data will be evaluated using the procedures specified in Section 9 of this QAPP. Accuracy also will be ensured by adhering to all sample handling procedures, sample preservation requirements and holding time periods.

Accuracy of field measurements obtained during soil, surface water and groundwater monitoring will be assessed by analyzing calibration check samples. Accuracy acceptance criteria for field measurements obtained during the field activities are located in the operations manual of the various field measurement devices that will be used for this project.

3.2.3 LABORATORY ACCURACY OBJECTIVES

Laboratory accuracy is assessed through the analysis of System Monitoring Compounds (SMC), Laboratory Control Samples (LCS), Matrix Spikes (MS), Matrix Spike Duplicates (MSD) or Standard Reference Materials (SRM) and the determination of percent recoveries (%R). The data generated demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The (%R) is calculated according to the following formula (USEPA, 2000):

$$\%R = \frac{\text{Spiked Sample Concentration} - \text{Unspiked Sample Concentration}}{\text{Concentration of Spike Added}} \times 100$$

SOPs for laboratory analyses are provided in Appendix A and contain the required accuracy, precision, sensitivity of the analyses.

3.3 COMPLETENESS

3.3.1 DEFINITION

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

3.3.2 FIELD COMPLETENESS OBJECTIVES

Field completeness is a measure of the amount of valid measurements obtained from the measurements taken in the project. The equation for completeness is presented in Section 12 of this QAPP. Field completeness for this project will be greater than 90 percent.

3.3.3 LABORATORY COMPLETENESS OBJECTIVES

Laboratory completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. The equation for completeness is presented in Section 12 of this QAPP. Laboratory completeness for this project should be 90 percent or greater.

3.4 REPRESENTATIVENESS

3.4.1 DEFINITION

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

3.4.2 MEASURES TO ENSURE REPRESENTATIVENESS OF FIELD DATA

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the RI/FS Work Plan and FSP are followed and that proper sampling techniques are used. Sampling programs were designed to provide data representative of AUS site conditions. During development of these programs, consideration was given to past waste disposal practices, existing analytical data, physical setting and processes and constraints inherent to the Superfund program. Representativeness is also assessed by the use of field blank samples to determine if the investigative samples are representative of the sampling location. The rationale of the sampling network is discussed in detail in Section 4 of the RI/FS Work Plan.

3.4.3 MEASURES TO ENSURE REPRESENTATIVENESS OF LABORATORY DATA

Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times and analyzing and assessing field duplicate samples. The sampling network is designed to provide data representative of AUS site conditions. During development of the sampling network, consideration was given to past waste disposal practices, existing analytical data, physical setting and processes, and other constraints inherent to the Superfund program. The rationale of the sampling network is discussed in detail in the RI/FS Work Plan.

3.5 COMPARABILITY

3.5.1 DEFINITION

Comparability is an expression of the confidence with which one data set can be compared with another. Comparability is also dependent on similar QA objectives.

3.5.2 MEASURES TO ENSURE COMPARABILITY OF FIELD DATA

The criteria for field comparability will be to ensure and document that the sampling networks designed for the RI are properly implemented and the sampling procedures in the FSP are followed for the duration of the sampling programs described in this QAPP.

3.5.3 MEASURES TO ENSURE COMPARABILITY OF LABORATORY DATA

The criteria for laboratory data comparability will be to ensure that the analytical methods used for the RI sampling and analysis events are comparable to the methods used for previous sampling events.

3.6 SENSITIVITY

3.6.1 DEFINITION

Sensitivity is the ability of the method or instrument to detect the contaminant of concern and other target compounds at the level of interest.

3.6.2 SENSITIVITY OF FIELD DATA

The field teams will monitor each of the field instruments to ensure that the readings are within the limits of the instrument as provided by the manufacturer. If a field instrument yields readings that seem to be erroneous, then field team members will notify the field supervisor and steps will be taken to remedy the situation. This may result in re-calibrating the instrument or replacing the instrument if necessary. Section 6 summarizes instrument sensitivity for the various field monitoring instruments.

3.6.3 SENSITIVITY OF LABORATORY DATA

STL evaluates and monitors its method and instrument sensitivity through the development of the laboratory method detection limits. A laboratory fortified blank, a blank that is spiked at the quantitation limit, is used in the development of the MDLs. Sensitivity is measured by calculating the percent recovery of the analytes at the quantitation limit. The STL SOP for MDL development has been provided in Appendix A of the QAPP and includes formulas for calculating analytical sensitivity. MDL studies are conducted by STL on an annual basis, a standard in the laboratory industry. Since changes in limits can occur over the life of a project, any changes in the MDLs as a result of these studies, or for any other reason, will be reported to USFWS via the Quality Control Summary Report.

3.7 LEVEL OF QUALITY CONTROL EFFORT

Equipment blanks, ambient blanks, trip blanks, method blanks, field duplicates, SRM, SMC and MS samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. Table 1.2 summarizes the type and number of QC samples to be collected during the investigation.

Equipment blank samples will be analyzed to check for procedural contamination at the AUS site that may cause sample contamination. Equipment blank samples will be collected by using laboratory-grade deionized water or organic-free water poured over the decontaminated sampling tools. If sampling equipment is being decontaminated based on organic contamination, then organic free water will be used as the final rinse for purposes of collecting the blank sample. Deionized water will be used if metals contamination is suspected. Equipment blank samples are used to determine whether the decontamination procedures used in the field may be contributing to cross-contamination or biasing analytical data. Equipment blanks will be prepared using AUS site sampling equipment. The equipment blank will be analyzed using the same methods as the accompanying investigative samples. The exception is that geotechnical analyses will not be conducted for equipment blank samples. Equipment blank samples will be collected at a frequency of one per group of 10 investigative aqueous samples and one per 20 investigative soil/sediment samples..

Trip blanks will also consist of laboratory-grade organic-free water. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage. Trip blanks will be analyzed for the complete list of VOCs only. Trip blanks are prepared by the laboratory prior to the sampling event in the same sample containers and are kept with the investigative samples throughout the sampling event. They are then packaged for shipment with other field samples and sent for analysis. There will be two trip blanks included in each sample shipping container containing multiple investigative aqueous VOC samples. At no time after their preparation are the trip blank sample containers to be opened before they reach the laboratory.

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. Duplicate samples are analyzed to check for sampling and analytical reproducibility and precision. Matrix Spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. Matrix Spikes are performed in duplicate and are hereinafter referred to as Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples. One MS/MSD duplicate will be collected for every 20 or fewer investigative samples (5 percent). MS/MSD samples will be submitted for all of the analyses proposed for this investigation (outlined on Table 1.2) with the exception of total suspended solids (TSS), total dissolved solids (TDS), total organic carbon (TOC) in a solid matrix, pH, permeability and particle size.

MS/MSD samples are investigative samples. Solid matrix MS/MSD samples require double the volume for the required analyses. However, aqueous matrix MS/MSD samples must be collected at triple the volume for the required analyses. One MS/MSD sample will be collected/designated for every 20 or fewer investigative samples per sample matrix.

Duplicate samples will be collected immediately following the collection of the investigative sample, using the same methods and procedures. The analytical results of duplicate samples will be compared with the standard sample results in order to measure field and laboratory reproducibility. Field duplicates will be collected at a frequency of one duplicate per 20 investigative samples (5 percent).

The level of QC effort provided by the laboratory will be equivalent to the level of QC effort specified under the contract laboratory program (CLP) for the Routine Analytical Service parameters to be tested. All data packages submitted to ENTRIX and NewFields will be Level IV, CLP equivalent. Please note that CLP is simply referenced as such. SW-846 methodologies will be utilized for the scope of work for this project.

The QC procedures for use of field instruments for field screening will include calibrating the instruments as described in the field SOPs included in the FSP, measuring duplicate samples, and checking the reproducibility of the measurements by taking multiple readings on a single sample or reference standard.

4.0 SAMPLING PROCEDURES

The sampling procedures to be used in this investigation have been selected to achieve the goals of the DQOs outlined in Section 1 of this QAPP. The RI/FS Work Plan and FSP outline all the sampling procedure information. Each of the topics that describe the sampling procedures are described below or referenced to other portions of the RI/FS Work Plan.

4.1 SAMPLING ACTIVITY

Sampling procedures are discussed in Section 4 of the FSP.

4.2 SAMPLE NETWORK DESIGN AND RATIONALE

Sampling Network Design and Rationale is discussed in Section 4 of the RI/FS Work Plan and Section 3 of the FSP.

4.3 SAMPLE CUSTODY PROCEDURE

Activities describing the appropriate Sample Custody Procedures are discussed in the following sections:

a. Sample Identification System is discussed in Section 5.1.1 of this QAPP.
b. Initiation of Field Custody Procedure is discussed in Section 5.1 of this QAPP.
c. Field Activity Documentation/Logbook is discussed in Section 5.1 of this QAPP.
d. Sample Shipment and Transfer of Custody is discussed in Section 5.1 of this QAPP.

The sample packaging and shipment procedures will insure that the samples will arrive at the laboratory with the COC intact. An example COC form is presented in Appendix B of this QAPP.

4.4 SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND MAXIMUM HOLDING TIMES

Samples collected for analysis will be contained and preserved in accordance with USEPA approved procedures. Tables 4.1 and 4.2 outline the necessary sample containers and preservation requirements for all proposed analyses.

All sample containers used for sample collection and analysis for this project will be prepared according to the procedures contained in the USEPA document, *Specifications and Guidance for Obtaining Contaminant-Free Sample Containers,* dated December 1992. This document specifies the acceptable types of containers, the specific cleaning procedures to be used before samples are collected, and QA/QC requirements relevant to the containers and cleaning procedures. STL will supply all sample containers utilized for this investigation. If field personnel observe any cracked, dirty, or the appropriate preservative missing in the sample bottles, those bottles will be discarded and STL will be notified of the problem to prevent its re-occurrence.

A list of sample containers, sample preservation and holding times are presented in Tables 4.1 and 4.2. The following provides a discussion of information provided in that table, presented by matrix and analytical groups.

4.4.1 SAMPLE CONTAINERS FOR SOLID MATRIX

Solid matrix samples for this investigation include soils and sediments. These samples will be submitted for the following analyses: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polynuclear aromatic hydrocarbons (PAHs), and inorganics included on the USEPA's Target Compound List (TCL) and Target Analyte List (TAL) (and boron) in addition to other project-specific constituents of concern. Solid samples will be submitted for the aforementioned analyses as well as analyzed for TCL organochlorine pesticides, organophosphorus pesticides, polychlorinated biphenyls (PCBs), explosives, total cyanide, nitrate-nitrite, perchlorate, sulfate, total phosphorous, alkalinity, TOC, dioxin/furans, grain size, permeability and pH. These analytical procedures are summarized in Table 1.2, including the appropriate method numbers. Sample vessels and preservation for each of these analyses is summarized below and also summarized in Tables 4.1 and 4.2.

The sample container used for collection of solid matrices for VOC analysis will vary based on the nature of the solid matrix. The container and the explanation for its use are described below for each matrix:

- Soil samples for VOC analysis will be collected in En Core™ sampling devices and stored and transported to the laboratory at 4 degrees Celsius (C) ±2 degrees C. En Core samples will be preserved at the laboratory within 48 hours from time of collection. Once preserved, the En Core sampler is discarded and the preserved sample may then be held for up to 14 days from time of collection until analysis.
- Sediment samples will be collected with a sediment corer whenever possible. If the depth of sediment is insufficient for discrete samples, composite samples will be collected as described in Section 4.1.1 of the FSP. After the sample is collected, it will be placed in a 2-ounce glass jar and preserved at 4 degrees C±2 degrees C, with a 14-day holding time before extraction and analysis. Due to the water content of sediment, an En Core™ sampling device is not effective for sampling this matrix.

Samples for SVOC, PAH, pesticides, PCBs, and dioxin/furan analysis will be collected in 500-milliliter (mL), wide-mouth glass jars, preserved at 4 degrees C +2 degrees C for a maximum holding time of 14 days to extraction and 40 days to analysis.

Samples for metals analysis will be collected in 500-mL wide-mouth, glass jars. Samples will be preserved at 4 degrees C +2 degrees C for a maximum holding time of 6 months for most metals, except for mercury, which has a holding time of 28 days.

Samples analyzed for explosives (including nitroglycerin and pentaerythritoltetranitrate (PETN) will be collected in 4-ounce glass jars, preserved at 4 degrees C +2 degrees C with a holding time of 14 days to extraction and 40 days to analysis.

Samples submitted for total cyanide, pH, TOC, nitrate-nitrite, sulfate, total phosphorous, and alkalinity analysis will be collected in 500-mL, wide-mouth glass jars, preserved at 4 degrees C +2 degrees C for a maximum holding time of 24 hours for pH (note: samples are analyzed upon receipt of the laboratory), 28 days for TOC, and 14 days for the other analyses.

Samples submitted for permeability and grain size analysis will be collected in Shelby tubes. There is no preservation or holding time requirement for these two parameters.

4.4.2 SAMPLE CONTAINERS FOR AQUEOUS MATRICES

For this investigation, aqueous samples will be collected from groundwater and surface water. These samples will be submitted to the laboratory for analysis of VOCs, SVOCs, and Inorganics. In addition to the methods listed above, all aqueous samples will be analyzed for organochlorine pesticides, organophosphorus pesticides, PCBs, PAHs, explosives, total cyanide, ammonia, nitrate-nitrite, total phosphorous/orthophosphate, methane/ethene/ethane, sulfide, sulfate, alkalinity, TDS, perchlorate and TSS. These analytical procedures are summarized in Table 1.2, including their corresponding method numbers. Sample vessels and preservation for each of these analyses are summarized below and also summarized in Tables 4.1 and 4.2.

Samples submitted for VOC analysis will be collected in three 40-mL glass vials, preserved with hydrochloric acid (HCl), at 4 degrees C +2 degrees C for a maximum holding time of 14 days to analysis.

Samples submitted for SVOC, PAH, pesticides, PCBs, and explosives (including nitroglycerin and PETN), and dioxin/furan analysis will be collected in one liter amber glass jars, preserved at 4 degrees C +2 degrees C for a maximum holding time of seven days to extraction and 40 days to analysis.

Samples submitted for total and dissolved metals analyses will be collected in one-liter plastic jars, preserved at 4 degrees C +2 degrees C with a holding time of six months. Samples analyzed for total metals will also be preserved with nitric acid. Aqueous samples submitted for dissolved metals analysis will be filtered in the field using a peristaltic pump, Teflon tubing and disposable 0.45 micron filters.

Samples for total cyanide analysis will be collected in 250-mL plastic containers, preserved at 4 degrees C +2 degrees C with sodium hydroxide, with a holding time of 14 days.

Samples submitted for ammonia and nitrate/nitrite analyses will be collected in 250-mL plastic containers, preserved at 4 degrees C +2 degrees C with sulfuric acid, with a holding time of 28 days.

Samples submitted for total phosphorus/orthophosphate, sulfate and perchlorate analyses will be collected in 250-mL plastic containers, preserved at 4 degrees C +2 degrees C with a holding time of 28 days.

Samples submitted for alkalinity, TDS, TSS, and pH analyses will be collected in 250-mL plastic containers, preserved at 4 degrees C+2 degrees C, with holding times of 14 days, seven days and seven days, respectively. The pH should be analyzed immediately upon receipt.

Samples submitted for methane/ethene/ethane analysis will be collected in 40-mL glass vials, preserved at 4 degrees C +2 degrees C with hydrochloric acid, with a holding time of 14 days.

Samples submitted for sulfide analysis will be collected in 500-mL plastic containers, preserved at 4 degrees C +2 degrees C with zinc acetate/sodium hydroxide, with a holding time of seven days.

4.5 SAMPLE HANDLING, PACKAGING AND SHIPMENT

The sampling team will assist the ENTRIX and/or CRA Field Supervisor with the preparation of samples for shipment to the laboratory. Following sample collection, the exterior of the sample containers will be decontaminated near the sampling location. Sample documentation and packaging will be performed in accordance with the procedures outlined in A Compendium of Superfund Field Operations Methods (USEPA, December 1987). Samples will be packaged for shipment as outlined in the FSP.

4.6 DECONTAMINATION PROCEDURES

General decontamination protocols applicable to a number of field activities to be completed during the RI/FS are summarized in Section 2.2 of the FSP.

4.6.1 DECONTAMINATION AND SOIL/GROUNDWATER SAMPLING

Refer to Sections 2.2.1 and 2.2.2 of the FSP for details on decontamination procedures while conducting soil and groundwater sampling.

4.6.2 DECONTAMINATION AND SURFACE WATER SAMPLING

Sections 2.2.3 and 2.2.3.1 of the FSP contain the detailed descriptions of decomtamination procedures while conducting surface water sampling.

4.6.3 DECONTAMINATION AND SEDIMENT SAMPLING

Sections 2.2.3 and 2.2.3.2 of the FSP contain the detailed descriptions for decontamination procedures while conducting soil and groundwater sampling.

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4.6.4 SAMPLE BOTTLES

Sample bottles will be decontaminated in accordance with the USEPA document "*Specifications and Guidance for Obtaining Contaminant-Free Sample Containers, December 1992*".

4.6.5 SAMPLE COLLECTION DEVICES

Refer to Sections 2.2.3 and 2.2.3.2 of the FSP for details on decontamination procedures while conducting soil and groundwater sampling.

4.7 MULTI-MEDIA SAMPLING PROCEDURES

The following media will be sampled as part of this investigation:

- Surface and subsurface soils;
- Sediments;
- Surface Water (i.e., impounded, ponded waters, and ephemeral/permanent wetlands); and
- Groundwater.

4.7.1 SURFACE WATER SAMPLING PROCEDURES

Surface water samples will be collected as indicated in the RI/FS Work Plan. Three types of surface water bodies to be sampled include: impounded water (including selected portions of Crab Orchard Lake); drainage water in streams and/or ditches that exit an AUS site; and selected ephemeral ponds and depressions. Unless otherwise stated in the RI/FS Work Plan, surface water samples will be collected in order to meet USEPA Level IV data package deliverable requirements necessary for the BRAs.

For detailed procedures for the sampling of surface water, refer to Section 4.1.2 of the FSP, as well as SOP 0025-003 (found in the FSP).

4.7.2 SEDIMENT SAMPLING PROCEDURES

Sediment samples will be paired with surface water samples, whenever possible. This approach will provide a more comprehensive assessment of AUS site conditions than either a sediment-only or surface water-only sampling program. Sediment samples will be collected where indicated in the RI/FS Work Plan. Unless otherwise stated in the RI/FS Work Plan, sediment samples will be collected in order to meet Level IV Validation to satisfy the requirements of the BRAs.

The detailed procedures for the sampling of sediment at the AUS site are found in SOP 0025 002, entitled "Standard Operating Procedure for Collecting Sediment Samples". This SOP is located in the FSP.

4.7.3 SOIL SAMPLING PROCEDURES

The soil sampling program is summarized in Section 5 of the RI/FS Work Plan and soil boring locations are illustrated on the figures of Section 5 of the RI/FS Work Plan. For detailed informaiton on soil sampling procedures, please refer to section 4.2 of the FSP, as well as SOP 4 (found in the FSP)..

4.7.4 GROUNDWATER SAMPLING PROCEDURES

The groundwater sampling program is summarized in Section 5 of the RI/FS Work Plan. Monitoring well locations are illustrated on the figures of Section 5 of the RI/FS Work Plan. The FSP and SOP 7 provide detailed procedures for groundwater sampling.

4.7.5 GEOTECHNICAL SAMPLING

During the RI, soil samples will be collected and analyzed for several geotechnical parameters to assist with evaluation of the site geology,hydrogeology, and evaluation of contaminant fate and transport. Geotechnical parameters include TOC, soil pH, permeability, and grain size. Geotechnical soil samples will be collected using either the DPT or HSA rigs. Geotechnical soil samples will be collected from the already proposed soil borings, and the monitoring well and piezometer boreholes.

The TOC and pH data will be used to evaluate fate and transport, and will be used to further evaluate collected soil and groundwater chemical data with respect to contaminate fate and transport (see section 5.2 of the FSP).

Permeability and grain size data will be collected to assist with the geologic and hydrogeologic evaluation of the AUS site. The objective is to collect one sample for permeability and grain size from each of the major overburden stratigraphic units encountered beneath the AUS site. The exact number of samples to be collected will be dependent upon the number of major stratigraphic units encountered.

4.8 PREVENTIVE MAINTENANCE PROCEDURE/SCHEDULE

Preventive maintenance activities are discussed in Section 11 of this QAPP.

5.0 CUSTODY PROCEDURES

Custody is one of several factors that are necessary for defensibility of environmental data in a court of law. Custody procedures help to satisfy the two major requirements of admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area.

A sample or evidence file is under custody if the following are true:

- The item is in actual possession of a person; or
- The item is in the view of the person after being in actual possession of the person; or
- The item was in actual physical possession but is locked in a storage container to prevent tampering; or
- The item is in a designated and identified secure area.

5.1 FIELD CUSTODY PROCEDURES

Field logbooks and data forms/sheets will provide the means of recording data collecting activities performed. As such, entries will be described in as much detail as possible so that persons going to the facility could reconstruct a particular situation without reliance on memory.

Field logbooks, survey books, or notebooks are to be bound and completed in waterproof ink. Logbooks will be assigned to field personnel, but will be stored in the appropriate environmental consultant's document control center when not in use. Each logbook will be identified by a sequentially-assigned project-specific document number on the inside cover.

The inside cover or title page of each logbook will contain the following:

- Person to whom the logbook is assigned;
- Logbook number;
- Project name;
- Project start date; and
- End date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the AUS site, field sampling or investigation team personnel and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. All entries will be made in ink, signed, and dated and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark, which is signed and dated by the sampler. Whenever a sample is collected, or a measurement is made, a detailed description of the location of the station, which includes compass and distance measurements, shall be recorded. The number of the photographs taken of the station, if any, will also be noted. Equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures as referenced in Section 4 of this QAPP.

5.1.1 SAMPLE IDENTIFICATION

The sample identification format for this investigation has been designed to uniquely identify each sample from each sampling program and event. This identification format is identical to the format used during the PA/SI. An example of the sample format is as follows, and is described below:

"AUS-OA2B-004-SL-05"

- AUS-___-___-___-___: All samples will have the "AUS" prefix;
- ____-OA2B-___-___-___: The second part of the number identifies the AUS OU site. The example describes Area 2B;
- ___-___-004-___-___: The third part of the number identifies the sample location within that area;
- ___-___-___-SL-___: The fourth part of the number identifies the media (i.e., SS=soil; SD=sediment; GW=groundwater; SW = surface water; SL=sludge). The fourth part also identifies a QC sample where appropriate (EB=equipment blank; AB=ambient blank, TB=trip blank);

- ___-___-___-___-05: If applicable, the last part of the number identifies the sample depth in feet, to the nearest foot of the bottom of the sample interval. "0X" in the fifth position indicates a sample collected from the surface to a depth of six inches.

For samples of waste material and samples collected from drums, the fourth and fifth positions will be replaced by a four-digit descriptor such as "drum" for a drum sample. Duplicate sample locations will be numbered sequentially starting with 500. This will ensure that duplicate samples cannot be distinguished from the original sample at the laboratory. The notes taken in the field log will detail the original sample for which it is a duplicate.

5.1.2 SAMPLE PACKING AND SHIPMENT

The sample packaging and shipment procedures summarized below will ensure that the samples will arrive at the laboratory with the COC intact. An example of a COC is included in Appendix B of this QAPP.

(a) The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples.

(b) All sample bottles will be identified by use of sample tags/labels with sample numbers, sampling locations, date/time of collection, sampler initials, preservative and type of analysis.

(c) Sample tags/labels are to be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample tag because the ballpoint pen would not function in freezing weather.

(d) Samples are accompanied by a properly completed COC form. The sample numbers and locations will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a courier service, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

(e) Samples will be properly packaged on ice at 4 degrees C for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. The preferred procedure includes use of a custody seal attached to the front right and back left of the cooler. The custody seals are covered with clear plastic tape. The cooler is strapped shut with strapping tape in at least two locations. Because three different laboratories are being utilized throughout STL's network, the field personnel will ship the samples to the appropriate laboratory based on the type of analysis requested.

(f) Whenever samples are located with a government agency, a separate sample receipt is prepared for those samples and marked to indicate with whom the samples are being co-located. The person relinquishing the samples to the facility or agency should request the representative's signature acknowledging sample receipt. If the representative is unavailable or refuses to sign, this is noted in the "Received By" space.

(g) The COC Record identifying the contents will accompany all shipments. The original record will accompany the shipment, and the pink and yellow copies will be retained by the sampler for return to the sampling office.

(h) If the samples are sent by common carrier, a bill of lading should be used. Receipts of bills of lading will be retained as part of the permanent documentation. If sent by mail, the package will be registered with return receipt requested. Commercial carriers are not required to sign off on the custody form as long as the custody forms are sealed inside the sample cooler and the custody seals remain intact.

(i) In general, samples will be transported to the laboratory by overnight carrier the same day the samples are collected in the field by overnight carrier. It is possible that samples could be stored in a secure location under the appropriate conditions (i.e., refrigerator) overnight if no holding times will be exceeded.

5.2 LABORATORY CUSTODY PROCEDURES

Laboratory custody procedures for sample receiving and log-in; sample storage and numbering; tracking during sample preparation and analysis; and storage of data are described in STL's sample receiving SOPs included in Appendix A of this QAPP.

5.3 FINAL EVIDENCE FILES

The final evidence file will be the central repository for documents that constitute evidence relevant to sampling and analysis activities as described in this QAPP. The environmental consultants are the custodians of the evidence files and maintain the contents of evidence files, including relevant records, reports, logs, field notebooks, pictures, subcontractor reports and data reviews in a secured, limited access area and under custody of the appropriate Project Managers. EcoChem will be the temporary custodian of the hardcopy analytical laboratory data packages that are generated from STL. EcoChem's office facilities are equipped with secure data storage rooms, which include electronically monitored entry and fire sprinkler systems. EcoChem maintains efficient, up-to-date work and production areas, which ensure ideal data and electronic data deliverable (EDD) storage and working conditions. EcoChem will use existing SOPs for data log-in and handling of both hardcopy and electronic data. The procedures are written in response to growing concerns for data security and tracking that are inherent in environmental investigations. An excerpt from EcoChem's Data Handling, Security and Storage SOP follows:

"Secure Data Storage: It is the policy of EcoChem to keep data and project files under secured storage. During office hours, a receptionist is at the front desk of our single-entrance office. After office hours, the building and floor are secured and the data room is locked."

"Data Validation Chemist:

- Remove data to be reviewed from storage box or envelope in data room, according to assignment on Data Log-In/Work Order;
- Obtain an orange Out Card;
- Fill in your name, project name and number, items removed for review, and the date in the appropriate columns;
- Put the completed Out Card in place of the data until review is completed;
- When review is complete, remove any paperclips, post-it notes, etc. added during data review;
- Return data to box immediately after review. Remove Out Card and cross out your entries."

"Project Coordinator/Data Custodian:

- When the project or phase is complete (e.g., final report has been accepted by client), remove the orange dot label from blue label on data box."

"Write date to be returned on blue label (30 days from date final report was submitted, unless other agreed-upon time limits are made with client). If the project has storage requirements, the data will be placed into inactive data storage (at EcoChem) or inventoried and sent to a third-party document archive (Iron Mountain)."

The final evidence file will include, at a minimum, the following:

- Field Logbooks
- Field Data and Data Deliverables
- Photographs
- Drawings
- Soil Boring Logs
- Laboratory Data Deliverables
- Data Validation Reports
- Data Assessment Reports
- Progress Reports, QA Reports, Interim Project Reports, Etc.
- All Custody Documentation (Tags, Forms, Airbills, etc.)

5.4 LONG-TERM STORAGE AND RETRIEVAL OF FINAL EVIDENCE FILES

All primary documents and related correspondence and calculations will be maintained at the NewFields Atlanta office under protection from damage, loss and deterioration. The filing will be traceable and retrievable. The files will be accessed only by team members from this investigation or approved auditors. All documents and records will be maintained including transmittal information specified in the AOC, Section XVII, in a manner conducive for retrieval. Distribution of documents is reflected with distribution lists attached to each transmittal; AOC parties and number of copies are specified in the AOC.

The AOC specifies that all documents related in anyway to the AUS OU must be retained for a minimum of 10 years after commencement of construction of any remedial action. After this 10-year period, federal agencies and the IEPA will be notified at least 90 days before the documents are scheduled to be destroyed. If a request is received to save documents, copies will be given to the agencies.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

This section describes the calibration procedures and the frequency at which these procedures will be performed for both field and laboratory instruments.

6.1 FIELD INSTRUMENT CALIBRATION

The following instruments will be utilized in the field: pH/temperature/conductivity meter, DO meter, PID, ORP meter, turbidity meter and interface meter (Table 6.1). Field instrumentation will be operated and calibrated according to the manufacturers' specifications. Field equipment calibration will be completed according to the frequency schedule outlined by the equipment manufacturer. As a rule, instruments will be calibrated daily prior to use. All field instruments will be calibrated at a minimum frequency of once daily and re-calibrated if the operator suspects the instrument is malfunctioning. For specific instructions on the calibration frequency, the acceptance criteria and the conditions that will require more frequent calibration, field teams will refer to the equipment manual for a given instrument. Calibration documentation procedures, at a minimum, will include the following:

a. Entries to the field logbooks will be made at least daily whenever the instrument is in use; and,

b. Calibration records that include:
    - Calibrator's name;
    - Standard(s) used;
    - Date/time of calibration; and
    - Corrective actions taken

Additionally, multiple readings on one sample or standard, as well as readings on replicate samples, will likewise be documented.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for a specific laboratory instrument will consist of initial calibration (3- or 5-points), initial calibration verification (ICV) and continuing calibration verification (CCV). For a description of the calibration procedures for a specific laboratory instrument, refer to the applicable SOPs that are included in Appendix A. The SOP for each analysis performed in the laboratory describes the calibration procedures, their frequency, acceptance criteria and the conditions that will require recalibration. In these cases, the initial calibration will be verified using an independently prepared calibration verification solution.

The laboratory maintains a sample logbook for each instrument which will contain the following information: instrument identification, serial number, date of calibration, analyst, calibration solutions run and the samples associated with these calibrations.

Calibration of laboratory equipment will be based on approved written procedures. Records of calibration, repairs, or replacement will be filed and maintained by the designated laboratory personnel performing QC activities. These records will be filed at the location where the work is performed and will be subject to QA audit. For the applicable instruments, the laboratory will maintain a factory-trained repair staff with in-house spare parts or will maintain service contracts with vendors.

The records of calibration will be kept as follows:

- A label will be affixed to each instrument showing description, manufacturer, model numbers, date of last calibration, by whom calibrated (signature), and due date of next calibration reports and compensation or correction figures will be maintained with instrument;
- A written stepwise calibration procedure will be available for each piece of test and measurement equipment; and
- Any instrument that is not calibrated to within the manufacturer's original specification will display a warning tag to alert the analyst that the device carries only a "Limited Calibration".
- Calibration dates are recorded on logsheets or electronically by data processing systems

All analyses will be governed by the appropriate laboratory SOPs, and appropriate calibration procedures and frequencies can be found in each SOP.

Volatile and Semivolatile Analyses by Methods 8260B and 8270C

Prior to calibration, the instrument(s) used for Gas Chromatograph/Mass Spectrometer (GC/MS) analyses are tuned by analysis of p-bromofluorobenzene for volatile analyses and decafluorotriphenyl phosphine for semi-volatile analyses. Once the tuning criteria for these reference compounds are met, the instrument should be initially calibrated by using a five-point calibration curve. The instrument tune will be verified each 12 hours of operation.

Continuing calibration is verified as specified in the method, or at least each working day, using criteria specified by the method. The calibration standards will be USEPA or National Institute of Standards and Technology (NIST) traceable and are spiked with internal standards and surrogate compounds. Whereas, calibration and CCV of instruments will be performed at approved intervals as specified by the manufacturer or the analytical method (whichever is more frequent). Calibration standards used as reference standards will be traceable to the NIST or USEPA when existent. The surrogate %R for each analyte group is provided in Tables 6.2 through 6.7.

Pesticide and PCB Analysis by Methods 8081 and 8082

Prior to analysis using the Gas Chromatograph (GC), the instrument is calibrated using a five-point calibration curve.

Single point calibration is used for multi-component pesticides (typically toxaphene and technical chlordane). For multi-component analytes, the mid level standard must be analyzed as part of the initial calibration. This single point calibration is used to quantitate multi-component analytes. The analyst may include a full five-point calibration for any of the multi-component analytes with the initial calibration.

The 12 hour calibration verification sequence must be analyzed within 12 hours of the start of the initial calibration and at least once every 12 hours thereafter if samples are being analyzed. If more than 12 hours have elapsed since the injection of the last sample in the analytical sequence, a new analytical sequence must be started with a 12 hour calibration. A mid level calibration standard is used for the 12 hour calibration.

For Pesticide analysis, the AB calibration mix is analyzed as the continuing calibration standard. At a minimum, this is analyzed after every 20 samples, including MS, laboratory control standards (LCS), and method blanks. If 12 hours elapse analyze the 12 hour standard sequence will be analyzed instead. The continuing calibration standard need not include multi-component analytes.

If instrument drift is expected due to sample matrix or other factors, it may be advisable to analyze the continuing calibration standard more frequently.

A five-point calibration of the Aroclor 1016/1260 mix is generated with at least mid level single points for the other Aroclor mixes. The average response factor is used to quantitate Aroclors 1260 and 1016, other Aroclors are quantitated from the mid level single point.

The analyst may include a full five-point calibration for any of the Aroclors with the initial calibration. The 12 hour calibration verification must be analyzed within 12 hours of the start of the initial calibration and at least once every 12 hours thereafter if samples are being analyzed. If there is a break in the analytical sequence of greater than 12 hours, then a new continuing calibration run must be analyzed before proceeding with the sequence. If more than 12 hours have elapsed since the injection of the last sample in the analytical sequence, a new analytical sequence must be started with a 12 hour calibration. At a minimum, the 12 hour calibration includes analysis of the Aroclor 1260/1016 mix. It is adequate to verify calibration with a mixture of Aroclors 1016 and 1260. If a specific Aroclor is expected, it may be included in the daily calibration check.

For this method samples must be bracketed with successful calibration verification runs. The Aroclor 1260/1016 calibration mix is analyzed as the calibration verification standard. This is analyzed after every 20 samples, including MS, LCS, and method blanks. A mid level standard is used for the calibration verification.

When using a dual column for analysis, the higher of two values will be reported unless professional judgment by the analyst dictates a different value is more appropriate.

Metals Analysis by Method 6010B

The Inductively Coupled Plasma (ICP) emission spectrophotometer instruments are calibrated by use of a minimum of three calibration standards prepared by dilution of certified stock solutions. An analysis blank is prepared with one calibration standard at the quantitation limit for the metal. The other standards bracket the concentration range of the samples. Calibration standards will contain acids at the same concentration as the digestates.

A continuing calibration standard, prepared from a different stock solution than that used for preparation of the calibration standards, is prepared and analyzed after each ten samples or each two hours of continuous operation. The value of the continuing calibration standard concentration must agree with + 10 percent of the initial value (+ 20 percent for mercury analysis) or the appropriate corrective action is taken which may include recalibrating the instrument and reanalyzing the previous ten samples.

For the ICP, linearity near the quantitation limit will be verified with a standard prepared at a concentration of two times the quantitation limit. This standard must be run at the beginning and end of each sample analysis run or a minimum of twice per eight-hour period.

Cyanide Analysis by Method 9012A

The instrument is calibrated at the beginning of each run and is verified at the beginning of the run by using a midrange ICV. The ICV is composed of the 0.1 ppm secondary standard. The correlation coefficient of the original curve must be > 0.995 or recalibration is required. The run is checked every ten samples and at the end of the run using a midrange CCV to verify continued linearity. It cannot vary from the original curve by more than ± 10% or recalibration is required. System cleanliness is checked every ten samples and at the end of the run using a continuing calibration blank (CCB). It cannot contain the analyte of interest above the reporting limit or recalibration is required. The previous 10 samples must be reanalyzed and bracketed by a CCB that passes criteria. The CCB is 0.25N sodium hydroxide. The distillation technique is checked by distilling a high and low standard and comparing the values obtained to the standard curve. The method recommends that the HI/LO standards be compared to the curve with a +/-10% agreement. The HI/LO standards are evaluated against all applicable batch QC.

Alkalinity by Method 3l0.1 – Initial Calibration

The pH meter is calibrated everyday with the 4 and the 7 calibration buffers and is verified at the beginning of the run by using the 10 buffer. The pH buffers should bracket the sample concentration.

Alkalinity by Method 310.1 – Continuous Calibration

The pH meter is checked every ten readings with a midrange (pH 7) buffer to ensure the calibration remain linear. The acceptance range for the calibration check is 7 ± 0.05 pH units or recalibration is necessary.

TOC by Method Walkley-Black

The titrant is standardized on a daily basis.

PH by Method 9045C

The pH meter is calibrated using a pH 4 and pH 7 buffer. A calibration check using pH buffer 10. The pH should be between 9.95 and 10.05 or recalibration is necessary. A pH 7 buffer is analyzed before analysis and every ten samples to ensure the calibration remains linear. The pH meter must be recalibrated if the buffer deviates by more than ± 2%. If this range is exceeded, reanalyze all samples analyzed since the last pH buffer that met criteria.

Sulfate by Method 300.0A

For each analyte of interest, a minimum of 3 calibration standards and a blank are prepared by adding accurately measured volumes of one or more stock standards to a volumetric flask and dilution to volume with reagent water. If a sample analyte concentration exceeds the calibration range the sample may be diluted to fall within the range. If this is not possible then three new calibration concentrations must be chosen, two of which must bracket the concentration of the sample analyte of interest. Each attenuation range of the instrument used to analyze a sample must be calibrated individually. Each calibration standard is injected into the instrument using a volume of 25 uL. The peak height or area responses are tabulated against the concentration. The results are used to prepare a calibration curve for each analyte. During this procedure, retention times (RT) must be recorded. All analytes are calibrated using a quadratic regression. The correlation coefficients (R2) must be 0.995 or better.

Nitrate/Nitrite by Method 353.2

An initial calibration curve is analyzed at the beginning of each run using five calibration standards. The correlation coefficient of the original curve must be less than or equal to 0.995 or re-calibration is required. The instrument is verified at the beginning of the run by using a mid-range CCV. The run is checked every 10 samples and at the end of the run using a mid-range CCV to verify continued linearity. It cannot vary from the original curve by more than 10% or the previous 10 samples from the last valid CCV are re-analyzed. System cleanliness is checked every 10 samples and at the end of the run using a CCB. It cannot contain the analyte of interest above the reporting limit or the previous 10 samples from the last valid CCB are re-analyzed. A nitrate standard (1 ppm) is run after the calibration to ensure cadmium column efficiency. Standard recovery must be within 10% of the true value. A nitrite standard (0.5 ppm) is run to ensure both channels are unilaterally linear.

Ammonia by Method 350.3

A five-point calibration curve is analyzed prior to analysis of samples. The coefficient must be –0.995 or greater, to proceed with sample analysis procedure. If the coefficient is less than –0.995, the standards are remade and reanalyzed. The run is checked at the beginning, every 10 readings and at the end of the run using a midrange CCV standard to verify continued linearity. It cannot vary from the theoretical value by more than ± 10% or recalibration and reanalysis of all readings following the last acceptable CCV is required.

Sulfide by Method 376.1

The titrant is standardized on a daily basis.

TSS and TDS by Methods 160.2 and 160.1

There is no calibration procedure for these methods.

Total Phosphorus and Orthophosphate by Method 365.2

Calibration standards are prepared in the same manner as samples. The absorbency of each calibration standard is obtained. The slope (B), y-intercept

(A), and correlation coefficient (r) are calculated and recorded. The correlation coefficient of the original curve must be ≥ 0.995 or recalibration is required. The run is checked every ten samples and at the end of the run using a midrange CCV to verify continued linearity. It cannot vary from the original curve by more than ± 10% or recalibration is required.

Methane/Ethene/Ethane by Method RSK-175

A calibration curve is generated. For each analyte, calculate the mean calibration factor from analyses of the calibration solutions. The standard deviation and RSD from each mean. The percent relative standard deviation (%RSD) average of all analytes must be ≤ 30%.

A CCV is analyzed at the beginning of each 24-hr analytical window. The CCV is fortified to the concentration of the middle calibration level. The percent difference between the CCV concentration factor (CF) and the calibration average CF for each analyte must be less than or equal to 30%.

High Resolution Mass Spectrometry by Method 8290

Calibration and standardization of a Gas Chromatograph/High Resolution Mass Spectrometer requires a check of mass resolution (tuning), a check of chromatographic resolution, a verification of descriptors, and a calibration curve/verification. Prior to calibration, the Gas Chromatograph/High Resolution Mass Spectrometer is tuned using perflourokerosene as the reference compound. Once the mass resolution is established, the chromatographic resolutions and descriptors (time windows during which specific m/z are monitored) are verified using the column performance mixture. When both mass and chromatographic resolution meet criteria, a calibration curve may be attempted. The instrument is calibrated using a 5-point calibration curve. The calibration curve is verified using a second-source standard. Each day, prior to analysis, mass and chromatographic resolution is verified as above. The calibration is verified at least daily, or as specified in the method. When available, calibration standards traceable to NIST are used.

Explosives Analysis by Method 8330

The High Performance Liquid Chromatography is calibrated using a minimum of 5 calibration standards. The lowest standard is at or below the reporting limit, and the highest standard defines the upper limit of linearity for the instrument. The calibration curve is verified using a second source. Daily, and at intervals specified in the method/SOP, the instrument calibration is verified by analysis of a mid-point standard.

Perchlorate by Method 8321A

Using HPLC/MS, a minimum 5-point calibration is performed, with the lowest standard at or below the reporting limit and the highest standard defining the upper limit of linearity for the instrument. Immediately following initial calibration, the calibration is verified utilizing a standard solution from a second source. Prior to sample analysis and throughout the analytical sequence as defined by the SOP, the continuing calibration is verified with a mid-level standard solution.0

Geotechnical Parameters

ASTM Method D2434: The balance is calibrated on each day of use, and the daily temperature measurement of the oven (s) is recorded.

ASTM Method D5084: There is no method specified calibration requirement.

ASTM Method D422: The sieves are calibrated twice a year using the National Bureau of Standard, Certificate of Calibration, SRMs 1017a, 1018a, 1019a calibrated glass beads. The hydrometers are calibrated twice a year and checked prior to each use. The thermometer is calibrated against a NIST certified thermometer.

7.0 ANALYTICAL PROCEDURES

Solid and aqueous samples collected for this investigation will be analyzed by STL. STL-North Canton will analyze samples for the following parameters: TAL metals (and boron), TCL VOCs and SVOCs (including other project-specific/organic constituents of concern), TCL organochlorine pesticides, PCBs, PAHs by SIM, total cyanide, alkalinity, TOC, pH, ammonia, nitrate/nitrite, phosphorous/orthophosphate, methane/ethene/ethane, sulfate, sulfide, TDS and TSS. STL-North Canton's contact information is:

4101 Shuffel Drive N.W.
North Canton, OH 44720
Phone: (330) 497-9396

STL-Sacramento will analyze samples for: explosives and perchlorate. STL-Sacramento's contact information is:

880 Riverside Parkway
Sacramento, CA 95605
Phone: (916) 373-5600

STL-Burlington will analyze samples for geotechnical parameters, specifically permeability and grain size. STL-Burlington's contact information is:

208 South Park Drive
Suite 1
Colchester, VT 05446
(802) 655-1203

The organophosphorus pesticide analyses will be performed by Pacific Agricultural Laboratory (PAL) out of Portland, Oregon. Pacific Agricultural Laboratories contact information is:

12505 Northwest Cornell Road
Portland, Oregon 97229
(503) 626-7943

Additionally, refer to Table 1.13 for all preparation methods. For the laboratories applicable Quality Management Plans and QC Programs, refer to Appendix C of this QAPP. For the laboratories applicable certifications, refer to Appendix D of this QAPP.

7.1 FIELD ANALYTICAL PROCEDURES

The following instruments will be used to collect field measurements while collecting soil, groundwater and surface water samples:

- Soil: VOCs will be measured using a PID (HNu Model PI-101 or equivalent).
- Groundwater: DO, specific conductance and temperature will be measured using a DO/conductivity/temperature meter (YSI Model 5563 or equivalent); ORP and pH will be measured with a ORP meter (YSI Model 5565 or equivalent); turbidity will be measured with a turbidity meter (HF Scientific Model DRT-15C or equivalent); water level/interface meter.
- Surface Water: Temperature and DO will be measured using a YSI 55 probe. The specific pH, conductivity, ORP meters will be selected prior to the beginning of field work or the same meters for these parameters that are mentioned in the previous bullet

The above-mentioned instruments are summarized in Table 6.1, which indicates each of the instrument's sensitivity and optimum range. The standardization and QA information for field measurements are described in Section 3 of this QAPP.

7.2 LABORATORY ANALYTICAL PROCEDURES

All samples will be analyzed according to the methods outlined in Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846) (USEPA, 1996b) and Methods for Chemical Analysis of Water and Wastes (USEPA, 1983). Solid matrix samples submitted for TCL VOC analysis will be analyzed using a closed-system purge-and-trap (and methanol extraction, if necessary based on the concentration of VOCs in the samples) sample concentration/introduction and GC/MS separation/detection techniques. TCL VOCs in aqueous samples will be analyzed using purge-and-trap sample concentration/introduction followed by GC/MS analysis.

TCL SVOCs will be solvent extracted from the solid or aqueous sample and the extract will be analyzed using GC/MS. TCL SVOCs will be solvent extracted from the soil or water sample and the extract will be analyzed using GC/MS.

The procedure for mercury analysis is a physical method based on the absorption of radiation at 253.7 nm by mercury vapor. A representative portion of the sample is digested in sulfuric and nitric acids. Organic mercury compounds are oxidized with potassium permanganate and potassium persulfate and the mercury reduced to its elemental state with stannous chloride and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance is measured as a function of mercury concentration. Concentration of the analyte in the sample is determined by comparison of the sample absorbance to the calibration curve (absorbance vs. concentration).

During the ICP procedure, samples are digested prior to analysis. The digestate is then analyzed. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio frequency. The spectra are dispersed by a grating spectrometer and the intensities of the emission lines are monitored by photomultiplier tubes. The photocurrents from the photomultiplier tubes are processed and controlled by a computer system.

Explosives are solvent extracted from the solid or aqueous sample and the extract is analyzed using liquid chromatography/mass spectrophotometry (LC/MS).

TCL organochlorine pesticides and PCBs will be solvent extracted from the solid/aqueous sample, separated by gas chromatography (GC), and detected using an electron capture detector.

TCL organophosphorus pesticides will be extracted using a liquid/liquid extraction for aqueous samples and a soxhlet sample extraction for solid samples. Aqueous samples are extracted at neutral pH using a liquid/liquid extraction, and solid samples are extracted with hexane/acetone (1:1) using a soxhlet sample extraction. The extracts are analyzed using gas chromatography/flame photometric detector (GC/PID) and gas chromatography/mass spectrometer (GC/MS) for confirmation.

Total cyanide will be determined by distilling an aliquot of the sample into a sodium hydroxide solution and determining total cyanide colorimetrically.

The analysis for methane/ethene/ethane will be performed by introducing a helium headspace above the aqueous sample and analyzing an aliquot of the headspace by GC with a flame ionization detector.

Alkalinity will be determined by titrating an aqueous sample with a standard acid solution to a known endpoint.

Nitrate/nitrite will be analyzed in aqueous samples using a spectrophotometer analyzer. Nitrate and nitrite will be reported separately.

Sulfate will be analyzed in water samples by ion chromatography/electrical conductivity separation/detection techniques. Sulfide in water samples will be analyzed by the iodometric method, which consists of back-titrating excess iodine added to oxidize sulfide in an autoanalyzer.

Ammonia (as nitrogen) will be determined potentiometrically using an ion-selective Ammonia electrode and specific ion meter.

For total phosphorus analysis, an aliquot of sample is digested to yield ortho-phosphate using sulfuric acid and ammonium persulfate. This aliquot is then reacted with ammonium molybdate and antimony potassium tartrate in an acid medium to form a blue colored complex which is analyzed photometrically.

For TOC analysis, an aliquot of a solid sample is treated with excess potassium dichromate and concentrated sulfuric acid. After treatment, the solution is backtitrated with ferrous sulfate to determine the amount of dichromate reduced during digestion.

For the determination of TDS, the homogenized sample will be filtered through a standard glass fiber filter. The filtrate will be evaporated and dried to a constant weight at 180°C.

Perchlorate in aqueous samples is determined utilizing either Ion Chromatography or HPLC/MS instrumentation. Samples are filtered, then injected onto the instrument for separation and measurement. Dilution of the sample with reagent water is performed in the event of high perchlorate concentrations or matrix interferences.

For TSS analysis, the homogenized sample will be filtered through a standard glass fiber filter and the residue retained is quantified. Samples will be dried at 103°C overnight.

The pH of a sample will be determined electrometrically by using an electrode. The pH meter will be calibrated with a series of known pH buffers.

Particle (grain) size of soils is determined by sieving, and particles less than 75 um (silts and clays) are determined by sedimentation using a hydrometer. This method can be modified for sieve only data.

Permeability of soils determines the coefficient of permeability through a granular soil (sands) with a constant head. The test is preferably conducted on a sample collected in a Shelby tube to maintain the soil as close as possible to in-situ. The test can also be conducted on a disturbed soil sample, after the soil is packed into a mold. Compaction of the soil can be completed to represent a minimum or maximum density. The test is conducted several times with the constant head (hydraulic head) being increased each run. Permeability by hydraulic conductivity determines the coefficient of permeability of water-saturated porous materials with a flexible wall permeameter. The test is preferably conducted on a sample collected in a Shelby tube to maintain the soil as close as possible to in-situ. The test can also be conducted on a disturbed soil sample, after the soil is packed into a mold. Compaction of the soil can be completed to represent a minimum or maximum density. This test is suitable for silts and clays.

7.2.1 LIST OF PROJECT TARGET COMPOUNDS AND LABORATORY DETECTION LIMITS

A complete listing of project target compounds, reporting limits, and method detection limits for each analyte group can be found in Tables 1.3 through 1.21 of this QAPP. Method detection limits shown have been experimentally determined using the method found in 40 CFR Part 136 Appendix B.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 FIELD QUALITY CONTROL CHECKS

QC procedures for the pH, temperature, conductivity, DO meters, and the ORP, turbidity, PID meters will include calibrating the instruments according to the manufacturer's specifications included in the Operations Manuals for each piece of equipment. Calibration instructions are included in FSP. Additionally, as described in Section 6.0 of the QAPP, measuring duplicate samples and checking the reproducibility of the measurements by taking multiple readings on a single sample or reference standard will be completed. The QC information for field equipment is stated in Section 3.0 of this QAPP. Assessment of field sampling precision and bias will be made by collecting field duplicates and field blanks for laboratory analysis. Collection of the samples will be in accordance with the applicable procedures in Section 4 of this QAPP.

8.2 LABORATORY QUALITY CONTROL CHECKS

STL has instituted a QC program to ensure the reliability and validity of the analyses performed at the laboratory. Analytical procedures are documented in writing as SOPs and each SOP includes a QC section that addresses the minimum QC requirements for the procedure. The internal QC checks might differ slightly for each individual procedure but in general the QC requirements include the following elements:

- Field/Trip blanks
- Method blanks
- Reagent/preparation blanks (applicable to inorganic analysis)
- Instrument blanks
- Calibration verifications
- MS/MSDs
- Surrogate (or SMC) spikes
- Analytical spikes
- Field duplicates
- Laboratory duplicates
- Laboratory control standards
- Internal standard areas for GC/MS analysis; control limits

- Mass tuning for GC/MS analysis
- Endrin/dichlorodiphenyltrichloroethane (DDT) degradation checks for Gas Chromatography using Electron Capture (GC/EC) analysis, and
- Dissimilar column confirmation for GC/EC analysis

Data obtained will be properly recorded. The data package will include a full deliverable package capable of allowing the recipient to reconstruct QC information and compare it to QC criteria. The laboratory will reanalyze any samples analyzed in nonconformance with the QC criteria, if sufficient volume is available. It is expected that sufficient volumes/weights of samples will be collected to allow for reanalysis when necessary.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data generated through in-field activities or by the laboratory operation shall be reduced and validated prior to reporting. No data shall be disseminated by the laboratory until it has been subjected to these procedures which are summarized in the following subsections below:

9.1 DATA REDUCTION

9.1.1 FIELD DATA REDUCTION PROCEDURES

Field data reduction procedures will be minimal in scope compared to those implemented in the laboratory setting. Only direct read instrumentation will be employed in the field. Field data review will include verification that QC checks and calibrations are recorded properly in the field logbooks and/or data sheets, and that the appropriate corrective action was implemented and recorded. Such data will be written into field logbook and/or data sheets immediately after measurements are taken. If errors are made, results will be legibly crossed out, initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. Later, the appropriate Field Supervisor, identified in Section 2 of this QAPP, will proof the field logbooks and/or data sheets to determine whether any transcription errors have been made by the field crew. If transcription errors have been made, the appropriate Field Supervisor and field crew will address the errors to provide resolution.

9.1.2 LABORATORY DATA REDUCTION PROCEDURES

Laboratory data reduction procedures will be followed according to the following protocol. All references to raw analytical data will be recorded in numerically identified laboratory notebooks. These notebooks will be issued by the STL QA Manager. Data are recorded in this notebook along with other pertinent information, such as the sample identification number and the sample tag number. Other details will also be recorded in the lab notebook, such as the analytical method used (SOP#), name of analyst, the date of analysis, matrix sampled, reagent concentrations, instrument settings, and the raw data. Each page of the notebook shall be signed and dated by the analyst. Copies of any strip chart printouts (such as gas chromatograms) will be maintained on file. Periodic review of these notebooks by the STL QA Manager takes place prior to final data reporting. (Records of notebook entry inspections are maintained by the STL QA Manager.)

QC data (e.g., laboratory duplicates, SMCs, SRM, MSs, and MSDs) will be compared to the method acceptance criteria. Data considered to be acceptable will be entered into the laboratory computer system. Data summaries will be sent to the STL QA Manager for review. If approved, data are logged into the project database format. The laboratory shall appropriately flag unacceptable data in the data package.

9.1.3 CHEMISTRY DATA REPORTING

Case narratives will be prepared which will include information concerning data that fell outside laboratory acceptance limits, and any other anomalous conditions encountered during sample analysis. The CLP equivalent Level IV data package shall include the following data elements:

1. Case Narrative:

- Any deviations from intended analytical strategy
- Laboratory lot number/sample delivery group (SDG)
- Numbers of samples and respective matrices
- QC procedures utilized and also references to the acceptance criteria
- Laboratory report contents
- Project name and number
- Condition of samples 'as-received'
- Discussion of whether or not sample holding times were met
- Discussion of technical problems or other observations which may have created analytical difficulties
- Discussion of any laboratory QC checks which failed to meet project criteria
- Signature of the STL QA Manager

2. Chemistry Data Package

- Case narrative for each analyzed batch of samples
- Summary page indicating dates of analyses for samples and laboratory QC checks

- Cross referencing of laboratory sample to project sample identification numbers
- Data qualifiers to be used should be adequately described
- Sample preparation and analyses for samples
- Sample results
- Raw data for sample results and laboratory QC samples
- Results of (dated) initial and continuing calibration checks, and GC/MS tuning results
- MS and MS duplicate recoveries, laboratory control samples, method blank results, calibration check compound, and system performance check compound results
- Labeled (and dated) chromatograms/spectra of sample results and laboratory QC checks
- Preparation factors and logbook notations

The laboratory shall also prepare and verify an EDD. The format of the EDD shall be in the approved Region 5 format.

For this investigation, STL will provide a standard or 21-day turn-around-time for the analytical data package and EDD. The 21-day timeframe begins the day the STL receives a given sample for analysis.

9.2 DATA VALIDATION

Data validation is the process of verifying that qualitative and quantitative information generated relative to a given sample is complete and accurate. Data validation procedures shall be performed for both field and laboratory operations as described below.

9.2.1 PROCEDURES USED TO EVALUATE FIELD DATA

Procedures to evaluate field data for this project primarily include checking for transcription errors and review of field logbooks/field data sheets, on the part of field crewmembers. Further, results of all instrument calibration will be reviewed by the ENTRIX or NewFields QA Manager to ensure that all criteria that are specified in this QAPP and associated SOPs are followed. Data collected from instruments not meeting calibration standards will be re-measured once the calibration problem has been solved. The appropriate Field Supervisor will be the responsible for ensuring that these measurements are re-taken. The appropriate Field Supervisor will otherwise not participate in making any of the field measurements, or in adding notes, data or other information to the logbook.

The evaluation (during third-party data validation) of equipment blanks and other field QC samples will provide definitive indications of the data quality. If a problem arises, it should be able to be isolated via the complete sample tracking and documentation procedures that will be performed. If such a problem does arise, corrective action can be instituted, documented, and reported to the agencies via the Quality Control Summary Report. If data are compromised due to a problem, appropriate data qualifications will be used to identify the data.

The handling, preservation and storage of samples collected during the sampling program will be monitored on an on-going basis. The project laboratories will document sample receipt including proper containers and preservation at the time samples are logged into their individual laboratory. The sample receipt records (a required data package deliverable) as well as the COC documentation will also be assessed during third-party data validation. Sample handling, storage or preservation problems identified during data validation will result in appropriate qualification of data.

9.2.2 PROCEDURES USED TO VALIDATE LABORATORY DATA

The purpose of chemistry data validation is to verify that the data are of known quality, are technically valid, are legally defensible, satisfy the project objectives, and are usable for their intended purpose. The objectives of the third-party data validation process will be to:

- Assess compliance to project specific procedures and programs.
- Evaluate system process control through review of control charts (if applicable).
- Verify that no systematic errors exist within the data sets.
- Assess field QC samples to determine if sampling has adversely impacted the reported results and, therefore, usability.
- Assess both method and laboratory performance through tabulation of QC outliers.

- Provide measures of data quality in terms of precision, accuracy, and completeness so that overall usability can be determined.

EcoChem has been contracted through ENTRIX to perform the third-party data validation and provide laboratory coordination and chemistry QA support. EcoChem's Project Manager, Eric Strout, will report directly to the ENTRIX QA Manager. EcoChem is located at:

EcoChem, Inc.
405 Westland Building
100 South King Street
Seattle, WA 98104-2885
Phone: 206-233-9332

The following guidance documents shall serve as the basis for data validation:

- USEPA National Functional Guidelines for Organic Data Review, (OSWER 9240.1-05A-P, PB99-963506, EPA 540/R-99-008, October 1999)
- USEPA National Functional Guidelines for Inorganic Data Review, (OSWER 9240.1-45, EPA 540-R-04-004, October 2004).
- USEPA National Functional Guidelines for Low Concentration Organic Data Review, (OSWER 9240.1-34, EPA540-R-00-006, June 2001)

9.2.2.1 VALIDATION APPROACH

The USEPA reviewed and approved a proposal to perform data validation using a "tiered" approach. One hundred percent (100%) of the data packages will be evaluated and qualified for all quantitative QC elements e.g., spike recoveries, method and field blank contamination, duplicate sample %RSD, and instrument stability and performance (e.g., initial and continuing calibration results, instrument tuning and internal standard areas) using hard-copy summary forms. This Summary Validation of 100% of the data is equivalent to an USEPA CLP "QA Level III" validation and is considered Tier 1. Specific QC elements that will be reviewed during the Summary Validation include:

- Presence and completeness of COC and “cooler receipt form” (also known as sample receipt form) documentation
- Sample Index (correlation of field sample ID to laboratory sample ID)

- Laboratory Case Narrative (method deviations and QC anomalies)
- Analytical holding times
- Where applicable, laboratory control standard recoveries
- Method blank contamination
- Surrogate spike recoveries
- Matrix spike compound recoveries
- Matrix spike/matrix spike duplicate RPD values
- Field duplicate RPD values
- Laboratory Duplicate RPD values
- Summaries of initial and continuing Calibration
- Summaries of instrument blanks (e.g., initial calibration blank, CCB, if specified in method)
- Review of reagent/preparation blanks (inorganics)
- Review of Laboratory Control Standards (LCS)
- Instrument stability and performance (e.g., tuning, DDT/endrin breakdown, serial dilution)
- Summaries of internal standards

Tier 2 is defined as a Full Validation (equivalent to an "USEPA CLP Level IV"). The Tier 2 validation includes all of the Tier 1 elements and a complete evaluation of all the raw data. A Full Data Validation (Tier 1 + Tier 2) will be performed for a minimum of 30% of the data. Additional quality indicators evaluated during Tier 2 include:

- Completeness of laboratory documentation for sample receipt, sample analysis, and sample result reporting
- Overall documentation practices
- Raw data for instrument stability and performance (e.g., mass tuning, DDT/endrin breakdown, internal standard areas, retention time (RT) windows, etc.)
- Interference check samples (ICP analysis)
- Serial dilutions (ICP analysis)
- Analytical spikes (graphite furnace analysis)
- Compound identification (GC methods) and quantitation

- Recalculation of results from raw data
- Transcription check (from raw data to final results)

The overall project minimum of 30% of the data packages (including those that are identified as "critical" during Tier 1 validation) will undergo Tier 2 validation. Several criteria can determine which data packages will undergo a Tier 2 review. The first criterion is that any data package identified as 'critical' by the Tier 1 process will undergo Tier 2 validation. A 'critical' package is defined as any data package that shows systematic outliers (generally 5% or more) for QC elements such as surrogate/spike recoveries, RPD values, or blank contamination. This ensures that any package that may potentially result in a large number of qualified (or rejected) data points will be subjected to the most thorough scrutiny by the validation. The second criterion is that a minimum of 30% of all data packages, representative of the entire project, are selected for Tier 2 validation. In order to achieve the 30% Full Validation (Level IV), data packages will be selected randomly (by EcoChem). Since the laboratory is producing full "CLP-like" data packages for all data, and all data packages are submitted to EcoChem, the selection of packages for Tier 2 is blind to the laboratory.

Project-specific Data Validation Worksheets will be completed for both tiers of validation. Examples of Data Validation Worksheets and other internal QC forms developed by EcoChem are included in Appendix E.

9.2.2.2 ECOCHEM DATA VALIDATION PROCESS AND INTERNAL QUALITY CONTROL

EcoChem follows a documented QA program, implemented by a comprehensive set of SOPs. The SOPs cover all technical facets of the data validation as well as auxiliary processes e.g., data log-in and tracking, database security and archive, document control, QC, software use and verification, algorithm verification, verification of manually input data, corrective action and training. A data validation flowchart is provided as Figure 9.1 of this QAPP.

The primary validation chemist using the hardcopy data package and printouts from the EDD performs the primary validation. The primary validation chemist tabulates and evaluates QC outliers; determines if the analyses were performed as required by the method and the project specific guidelines; performs calculation checks (Tier 2 only) using spreadsheets developed by EcoChem; and summarizes the findings in a written technical summary, to be included in the validation report. If necessary, the primary review chemist will contact the laboratory for further information, clarification, or needed resubmission. All communications will be documented and included with the Data Validation Worksheets. The data, worksheets, and report will then be submitted to the secondary review chemist.

The secondary review chemist reviews the report and verifies the content against the worksheets and proposed qualifiers. The report is also reviewed for clarity and usability. All technical assessments (especially those involving qualifiers) are reviewed and accepted, or discussed with the primary review chemist. Any necessary corrections are made by the primary review chemist, and checked by the secondary. If the primary and secondary review chemists cannot reach consensus on a technical point, the issue is forwarded to the EcoChem Project Manager, who will make the final judgment. The secondary review chemist also performs random checks of calculations and sample identifications. All issued qualifiers are verified. When the secondary review chemist is satisfied with the worksheets and report, the Secondary Review Checklist is completed, and the technical report section, worksheets, and qualified transfer files are submitted to the Project Coordinator.

The EcoChem Project Coordinator gathers all worksheets and technical report sections for a project, verifying that all submitted data sets were validated at the appropriate level (Tier 1 or Tier 2), and that all necessary documentation has been turned in. The technical report sections are checked for formatting and consistency, and compiled into the desired reporting style. The compiled reports are then submitted to the appropriate EcoChem Technical Task Managers.

The EcoChem Task Managers review the reports for clarity, consistency, and accuracy. Random checks of qualifiers and sample identifications are performed. The Task Managers also review the reports to see if the project DQOs were met. Finally, the Task Manager(s) write the QA summary sections for the validation reports. When the validation narratives are complete, the final deliverable is assembled (including study area QA reports, qualified EDD, and communication records). The EcoChem Project Manager completes a Project Management Approval and Release form. The final deliverable and internal QC forms and checklists are then submitted to the EcoChem Project Manager for final review and approval. The final deliverable will not be shipped to ENTRIX or NewFields unless all levels of EcoChem review and approval are complete.

9.3 DATA REPORTING

Data reporting procedures shall be carried out for field and laboratory operations as indicated in the following subsections:

9.3.1 FIELD DATA REPORTING

Field data reporting shall be conducted principally through the transmission of the information written in the field log books/data sheets containing tabulated results of measurements made in the field, and documentation of field calibration activities. In addition to the field notes, there are activity specific data forms that will be completed. These forms include the following:

- Boring/Monitoring Well Log
- Groundwater Sampling Field Data Sheet
- Groundwater Level Data
- Sediment Sampling Field Data Sheet
- Surface Water Sampling Field Data Sheet
- Audit Finding Report
- Audit Checklist for Water Sampling
- Audit Checklist for Sediment Sampling
- Photograph Log
- Data form for Soil Sampling
- Audit checklists for soil and groundwater sampling
- Well development log

A copy of each of the above listed forms is included in the FSP. A Boring/Monitoring Well Log is to be completed for each boring, piezometer, and/or monitoring well. A Groundwater Sampling Field Data Sheet and Groundwater Level Data is to be completed for each sampling location (i.e., for each well or piezometer). A Sediment Sampling Field Data Sheet is to be completed for each sediment sample location. Surface Water Sampling Field Data Sheet is to be completed for each surface water sample location. The audit forms are used when conducting an audit and Photograph Log will be completed to describe photographs taken. A copy of all completed field data forms will be included in appendices of the RI Report

9.3.2 DATA USABILITY AND FINAL REPORTING

Laboratory packages (hardcopy and EDDs) summarizing the data generated for this investigation will be validated as described in this Section. Once validated, the data will be loaded into a project database managed by NewFields. Data usability will be determined by NewFields and ENTRIX based on the results of data validation and overall comparison to DQOs. NewFields and ENTRIX will follow USEPA guidance in determining whether data is usable for risk assessment.

The following Sections in the RI/FS Work Plan discuss data usability and reporting: Section 4 describes the sample collection.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the RI/FS Work Plan, the FSP, and the QAPP. The audits of field and laboratory activities include two independent parts, an internal audit and an external audit.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

10.1.1 INTERNAL FIELD AUDITS

10.1.1.1 INTERNAL FIELD AUDIT RESPONSIBILITIES

Internal audits of field activities including sampling and field measurements will be conducted by the ENTRIX or NewFields QA Manager.

10.1.1.2 INTERNAL FIELD AUDIT FREQUENCY

These audits will verify that established procedures are being followed. Internal field audits will be conducted quarterly, with at least one at the beginning of the AUS site sample collection activities. Although audits should be conducted quarterly, more frequent audits may be appropriate if field crews are rotated often.

10.1.1.3 INTERNAL FIELD AUDIT PROCEDURES

The internal field audits will include examination of field sampling records, field instrument operating records, sample collection, handling, decontamination (reference section 2.2 of the FSP), and packaging in compliance with the established procedures, maintenance of QA procedures, COC, etc. Follow-up audits will be conducted to correct deficiencies, and to verify that QA procedures are maintained throughout the investigation. The audits will involve review of field measurement records, and sample documentation. The results of field audits will be documented on field audit data sheets or other equivalent paperwork (please refer to the surface water collection SOP located in the FSP for an example of a field audit data sheet). The completed field audit report will be kept on file by the QA Manager and the report will be made available to the agencies with the monthly report to the agency during those months that an audit is available.. After a field audit is conducted, the results of the audit will be shared by the auditor with the field teams prior to additional sampling to enhance sampling performance where applicable.

10.1.2 EXTERNAL FIELD AUDITS

10.1.2.1 EXTERNAL FIELD AUDIT RESPONSIBILITIES

External field audits may be conducted by representatives from the Agencies.

10.1.2.2 EXTERNAL FIELD AUDIT FREQUENCY

External field audits may be conducted at any time during the field operations. These audits may or may not be announced and are at the discretion of the Agencies.

10.1.2.3 OVERVIEW OF THE EXTERNAL FIELD AUDIT PROCESS

External field audits will be conducted according to the field activity information presented in the field SOPs or in the sampling procedures outlined in the FSP. Results of the external field audit may document the need for a change to procedures in the FSP and/or QAPP and result in the need for an amendment to the FSP and/or QAPP.

10.2 LABORATORY PERFORMANCE AND SYSTEMS AUDITS

10.2.1 INTERNAL LABORATORY AUDITS

10.2.1.1 INTERNAL LABORATORY AUDIT RESPONSIBILITIES

The internal laboratory audit will be conducted by the STL QA Officer at each laboratory utilized for the investigation.

10.2.1.2 INTERNAL LABORATORY AUDIT FREQUENCY

The internal laboratory system audits will be conducted on an annual basis while the internal lab performance audits will be conducted on a quarterly basis.

10.2.1.3 INTERNAL LAB AUDIT PROCEDURES

The internal laboratory system audits will include an examination of laboratory documentation on sample receiving, sample log-in, sample storage, COC procedures, sample preparation and analysis, instrument operating records, etc. The performance audits will involve preparing blind QC samples and submitting them along with project samples to the laboratory for analysis throughout the project. The STL QA Officer from each laboratory utilized for this investigation will evaluate the analytical results of these blind performance samples to ensure the laboratory maintains acceptable QC performance.

10.2.2 EXTERNAL LABORATORY AUDITS

10.2.2.1 EXTERNAL LABORATORY AUDIT RESPONSIBILITIES

An external laboratory audit may be conducted by representatives from the Agencies at any time.

10.2.2.2 EXTERNAL LABORATORY AUDIT FREQUENCY

An external laboratory audit may be conducted at least once prior to the initiation of the sampling and analysis activities. These audits may or may not be announced, may be conducted at any time and are at the discretion of the Agencies.

10.2.2.3 OVERVIEW OF THE EXTERNAL LABORATORY AUDIT PROCESS

External laboratory audits will include (but not be limited to) review of laboratory analytical procedures, laboratory on-site audits, and/or submission of performance evaluation samples to the laboratory for analysis. Typically, the external laboratory audit will be conducted in the lab so that the staff may be questioned regarding laboratory procedure. A recently produced sample data package will be compared with their SOP to ensure compliance with applicable standards.

11.0 PREVENTIVE MAINTENANCE

11.1 FIELD INSTRUMENT PREVENTIVE MAINTENANCE

Specific preventive maintenance procedures to be followed for field equipment are those recommended by the manufacturer. Field instruments will be checked and calibrated daily before use. Calibration checks and measures for preventive maintenance will be documented on the Field logbooks. The maintenance schedule and trouble-shooting procedures for field instruments are indicated in the information included in the FSP. Critical spare parts such as tape, lamps, chargers, electrode, and batteries will be kept on-site to reduce downtime. Backup instruments and equipment will be available on-site or within one day shipment to avoid delays in the field schedule. All preventive maintenance and repair activities will be entered into the field notebook. For a list of field instruments, refer to Table 6.1.

11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

As part of their QA/QC Program, a routine preventive maintenance program is conducted by STL to minimize the occurrence of instrument failure and other system malfunctions. The Laboratory has an internal group to perform routine scheduled maintenance, and to repair or to coordinate with the vendor for the repair of all instruments. Laboratory instruments are to be maintained in accordance with manufacturer's specifications and the requirements of the specific method employed. This maintenance is to be carried out on a regular, scheduled basis, and is documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturer's maintenance is provided under a repair and maintenance contract with factory representatives.

A preventive maintenance schedule for laboratory equipment is provided as Tables 11.1 through 11.10.

11.3 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Prior to use, all supplies and consumables will be inspected by both field and laboratory personnel to ensure that clean and well-functioning supplies are used during the investigation. Example scenarios that will result in the elimination of supplies are described below:

- Core liners – if cracks are observed or if the liner has been removed from the manufacturer's packaging material it will be discarded;
- Sampling Gloves – if tears, holes, or distressed areas are found in sampling gloves they will be discarded; and
- Sample Vessels – if cracks, dirt, or a lack of preservative is observed, the sample container will be discarded.

Consumable supplies must meet the manufacturers' standards before use in the field. The following information outlines the cleaning procedures for various sample containers as provided by Quality Environmental Containers, 1997:

Sample Type: Semivolatile organics, pesticides, metals, cyanide, nitrite/nitrate in solid and aqueous matrices.

1. Containers are physically inspected for defects or visible contamination.
2. Containers are then placed in individual cleaning racks and processed through a wash of a mixture of nitric acid.
3. Three rinse cycles – tap water.
4. Containers are washed in non-phosphate, biodegradable detergent.
5. One rinse cycle – tap water.
6. Four rinse cycles – deionized water.
7. Containers are dried for hour hours in sterile stainless steel drying room.
8. Containers are then assembled in an organic free environment, packaged and immediately shrink wrapped and stored in a contaminant-free holding area until lot analyses is completed.

Sample Type: Purgeable (Volatile) Organics in Solid and Aqueous Matrices

1. Containers are physically inspected for defects or visible contamination.
2. Containers are then placed in individual cleaning racks.
3. Containers are washed in noon-phosphate, biodegradable detergent.
4. One rinse cycle – tap water.
5. Four rinse cycles – deionized water.
6. Containers are dried for four hours in sterile stainless steel drying room.

7. Containers are then assembled in an organic free environment, packaged an immediately shrink wrapped and stored in a contaminant-free holding area until lot analysis is completed.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

12.1 PRECISION ASSESSMENT

Precision is determined by splitting spiked or unspiked samples. This allows the analyst to determine the precision of the preparation and analytical techniques used to analyze the duplicate sample. MS samples are prepared by choosing a sample at random from each sample shipment received at the laboratory or is pre-selected by field personnel and labeled according, dividing the sample into equal aliquots, and then spiking each of the aliquots with a known concentration and numbers of analytes. The MS/MSD will be then included in the analytical sample set. Precision will also be assessed by LCSs run in duplicate (LCS/laboratory control spike duplicate (LCS/LCSD)). These samples are prepared with laboratory water and will not reflect any characteristics of the AUS site, unlike the MS/MSD samples. LCS/LCSD samples will reflect the precision of the analytical procedure and instrumentation. Field Duplicate samples will also be collected in the field. The duplicate analytical sample will have a unique label, which will be noted in the field logbook so that the actual location can be later identified. This duplicate will indicate the quality of sample collection as well as sample analysis. The RPD between the spike and duplicate spike will be calculated and plotted. The RPD is calculated according to the following formula (USEPA, 2000):

$$RPD = \frac{S-D}{(S+D)/2} X\ 100$$

Where:S = First sample value (original or MS value);
D = Second sample value (duplicate or MS duplicate value)

12.2 ACCURACY ASSESSMENT

In order to assure the accuracy of the analytical procedures, percent recoveries will be calculated from samples spiked with known concentrations of analytes. The MS/MSD and LCS/LCSD samples described above will be used to assess accuracy, as well. However, the results of the duplicate pairs will not be compared, rather, the results from each sample will be assessed independently. In general, a sample spike will be included in every set of 20 samples tested on each instrument. LCS/LCSD samples are used to assess accuracy of the laboratory methodology and instrumentation. Any significant increase or decrease in concentration of the spiked analyte will be due to sample contamination or analyte coelution or retention in a GC column. For example, if the %R for acetone exceeded QC criteria in the LCS/LCSD sample, then acetone is present in the laboratory. Results for the analysis of MS/MSD samples outside of QC limits would indicate matrix interference. For MS/MSD samples with percent recoveries outside accuracy QC limits, the sample matrix has interfered with the analytical results. Daily control charts will be plotted for each commonly analyzed compound and kept on instrument-specific, matrix - specific, and analyte - specific bases. The %R for a spiked sample is calculated according to the following formula (USEPA, 2000):

$$\%\ \text{Recovery Accuracy} = \frac{\text{Spiked Sample Concentration} - \text{Unspiked Sample Concentration}}{\text{Spiked Concentration added}} \times 100$$

In addition to the information cited above, accuracy of laboratory results will be assessed for compliance with the established QC criteria in accordance with site-specific DQOs that are outlined in the RI/FS Workplan using the analytical results of surrogate compounds, laboratory control samples, duplicate samples and MS/MSD samples. %R and RPDs per analyte as well as surrogate compounds are summarized on Tables 12.1 through 12.11.

12.3 COMPLETENESS ASSESSMENT

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{(\text{number of valid measurements})}{(\text{number of measurements planned})} \times 100$$

13.0 CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or out-of-QC performance which can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation and data assessment. Corrective action proposed and implemented will be documented in the regular QA reports to management. Corrective action should only be implemented after approval by the appropriate Project Manager, or his/her designee. If immediate corrective action is required, approvals secured by telephone from the appropriate Project Manager should be documented in an additional memorandum.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem will be responsible for notifying the appropriate Project Manager, who in turn will notify the Project Coordinators from the agencies and the environmental consultant project managers. Implementation of corrective action to resolve the problem will be confirmed in writing through the same channels.

Any nonconformance with the established QC procedures in the QAPP or RI/FS Work Plan will be identified and corrected in accordance with the QAPP.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by a stop-work order issued by the appropriate Project Manager.

13.1 FIELD CORRECTIVE ACTION

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the QAPP, etc.), sampling procedures and/or field analytical procedures require modification due to unexpected conditions. Technical staff and project personnel will be responsible for reporting suspected technical or QA non-conformances or suspected deficiencies of any activity or issued document by reporting the situation to the ENTRIX Field Supervisor or CRA Field Supervisor, or his/her designee. This individual will be responsible for assessing the suspected problems in consultation with the ENTRIX or NewFields

QA Manager on making a decision based on the potential for the situation to impact the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the ENTRIX/NewFields QA Manager.

The ENTRIX/NewFields QA Manager will be responsible for ensuring that corrective action for non-conformances are initiated by the following actions:

- Evaluating reported non-conformances;
- Controlling additional work on nonconforming items;
- Determining disposition or action to be taken;
- Maintaining a log of non-conformances;
- Reviewing nonconformance reports and corrective actions taken; and
- Ensuring nonconformance reports are included in the final documentation in project files.

The ENTRIX/CRA Field Supervisor or his/her designee will then ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include following:

- Repeat the measurement to check the error;
- Check for proper adjustments for ambient conditions such as temperature;
- Check the batteries;
- Re-Calibration;
- Replace the instrument or measurement devices; and
- Stop work (if necessary).

The RI/FS Field Supervisor or his/her designee is responsible for AUS site activities. In this role, the Field Supervisor is required to adjust the AUS site programs as warranted to accommodate AUS site-specific needs. When it becomes necessary to modify a program, the CRA Field Supervisor notifies the ENTRIX/NewFields Project Manager of the anticipated change and implements the necessary changes after obtaining the approval of FWS. The change in the program will be documented. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and action taken.

The ENTRIX/NewFields Project Manager is responsible for the controlling, tracking, and implementation of the identified changes. Reports on changes will be distributed to affected parties that include the agency Project Coordinators. Additionally, the agency Project Coordinators will be notified whenever program changes in the field are made.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The ENTRIX/NewFields QA Manager will identify deficiencies and recommended corrective action to the appropriate Project Manager. Implementation of corrective actions will be performed by the Field Supervisor and field team. Corrective action will be documented in QA reports to the entire project management.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels as described earlier.

13.2 LABORATORY CORRECTIVE ACTION

Corrective action in the laboratory may occur prior to, during and after initial analyses. A number of conditions such as broken sample containers, multiple phases, low/high pH readings and potentially high concentration samples may be identified during sample log-in or just prior to analysis. Following consultation with lab analysts and section leaders, it may be necessary for the laboratory QA Manager to approve the implementation of corrective action. The submitted SOPs found in Appendix A of the QAPP specify some conditions during or after analysis that may automatically trigger corrective action or optional procedures. These conditions may include dilution of samples, additional sample extract cleanup, automatic re-injection/reanalysis when certain QC criteria are not met, etc.

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is somewhat dependent on the analysis and the event.

Laboratory personnel are alerted that corrective actions may be necessary if one or more of the following conditions exist:

- QC data are outside the warning or acceptable windows for precision and accuracy;
- Blanks contain target analytes above acceptable levels;
- Undesirable trends are detected in spike recoveries or RPD between duplicates;
- There are unusual changes in detection limits;
- Deficiencies are detected by the QA Department during internal or external audits or from the results of performance evaluation samples; or
- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the QA department.

These corrective actions are performed prior to release of the data from the laboratory. The corrective actions will be documented in both STL's corrective action log (signed by analyst, section leader and QC coordinator), and the narrative data report sent from the laboratory to the data validator. If corrective action does not rectify the situation, the laboratory will contact the Entrix Project Manager.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

The Entrix/NewFields Project Manager may identify the need for corrective action during either the data validation or data assessment. Potential types of corrective action may include re-sampling by the field team, re-injection/reanalysis of samples by the laboratory, or re-submission of data packages with corrected clerical errors. These corrective actions are dependent upon the ability to mobilize the field team and whether the data to be collected is necessary to meet the required QA objectives (e.g. the holding time for samples is not exceeded, etc.) When the data assessor identifies a corrective action situation, it is the Entrix/NewFields Project Manager who will be responsible for approving the implementation of corrective action, including re-sampling, during data assessment. Corrective actions of this type will be documented by the ENTRIX or NewFields QA Manager.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The deliverables associated with the tasks identified in the RI/FS and monthly progress reports will contain QA discussions in which data quality information collected during the task is summarized. Those reports will be the responsibility of the NewFields Project Manager and will include the ENTRIX/NewFields QA Manager's report on the accuracy, precision, and completeness of the data as well as the results of the performance and system audits, and any corrective action needed or taken during the project.

14.1 CONTENTS OF PROJECT QA REPORTS

The QA reports will contain, on a routine basis, the results of field and laboratory audits, information generated during the past month reflecting on the achievement of specific DQOs and a summary of corrective action that was implemented and its immediate results on the project. The status of the project with respect to the project schedule included in the QAPP will be determined. Whenever necessary, updates on training provided, changes in key personnel, and/or anticipated problems in the field or lab for the coming month that could bear on data quality along with proposed solutions, will be reported. Detailed references to QAPP modifications will also be highlighted. All QA reports will be prepared in written, final format and approved by the NewFields Project Manager or their designee.

In the event of an emergency, or in case it is essential to implement corrective action immediately, QA reports can be made by telephone to the appropriate individuals, as identified in the Project Organization or Corrective Action sections of this QAPP. However, these events, and their resolution will be addressed thoroughly in the next issue of the monthly QA report.

14.2 CONTENTS OF PROJECT DATA QUALITY REPORTS

Data Quality Reports will include, at a minimum, the following components:

- *Cover Page* - Site name, laboratory, collection date(s), SDG number(s), sample ID index, and EcoChem project number.
- *Project Narrative* - Description of the sample set, methods of analysis, and basis for validation including any deviations or modifications to data validation procedures, chemists providing the primary and secondary validation, definition of qualifiers and codes.

- *Summary of Data Quality* - Usability of the data set (by area or operable unit) in terms of completeness, accuracy, precision and field collection quality. Supporting tables of QC outliers, organized by quality parameter (i.e., accuracy for metals would include all data points qualified for %R outliers may be included.
- *Technical Section for Each Method/Matrix* - Details of all technical deficiencies and qualifiers
- *Appendices*
    - Definition of validation qualifiers and reason codes
    - Summary table of data validation criteria and actions
    - Qualified Data Summary Tables by SDG/method
    - Copies of Data Validation Worksheets
    - Copies of communications and requests for supplemental or additional data; copies of all applicable re-submissions

Qualified laboratory EDDs will be submitted as validation is completed for each set of analytical packages (usually within a 30-day turnaround). The Data Quality Reports will be prepared when all validation for a specified area or sampling is completed.

14.3 FREQUENCY OF QA REPORTS

The QA Reports will be prepared on a monthly basis, and will be delivered to all recipients as part of the monthly progress report. The reports will continue without interruption, until the project has been completed. Anticipated recipients of the QA Reports will be the Project Coordinators and/or Project Managers for the USEPA, IEPA, FWS, ENTRIX, NewFields and CRA. The frequency of any emergency reports that must be delivered verbally cannot be estimated at the present time.

The Data Quality Reports will be prepared as the validation for a specified area or sampling is completed. Qualified laboratory EDD will be submitted as validation is completed for each set of analytical packages (usually within a 30-day turnaround).

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FIGURES

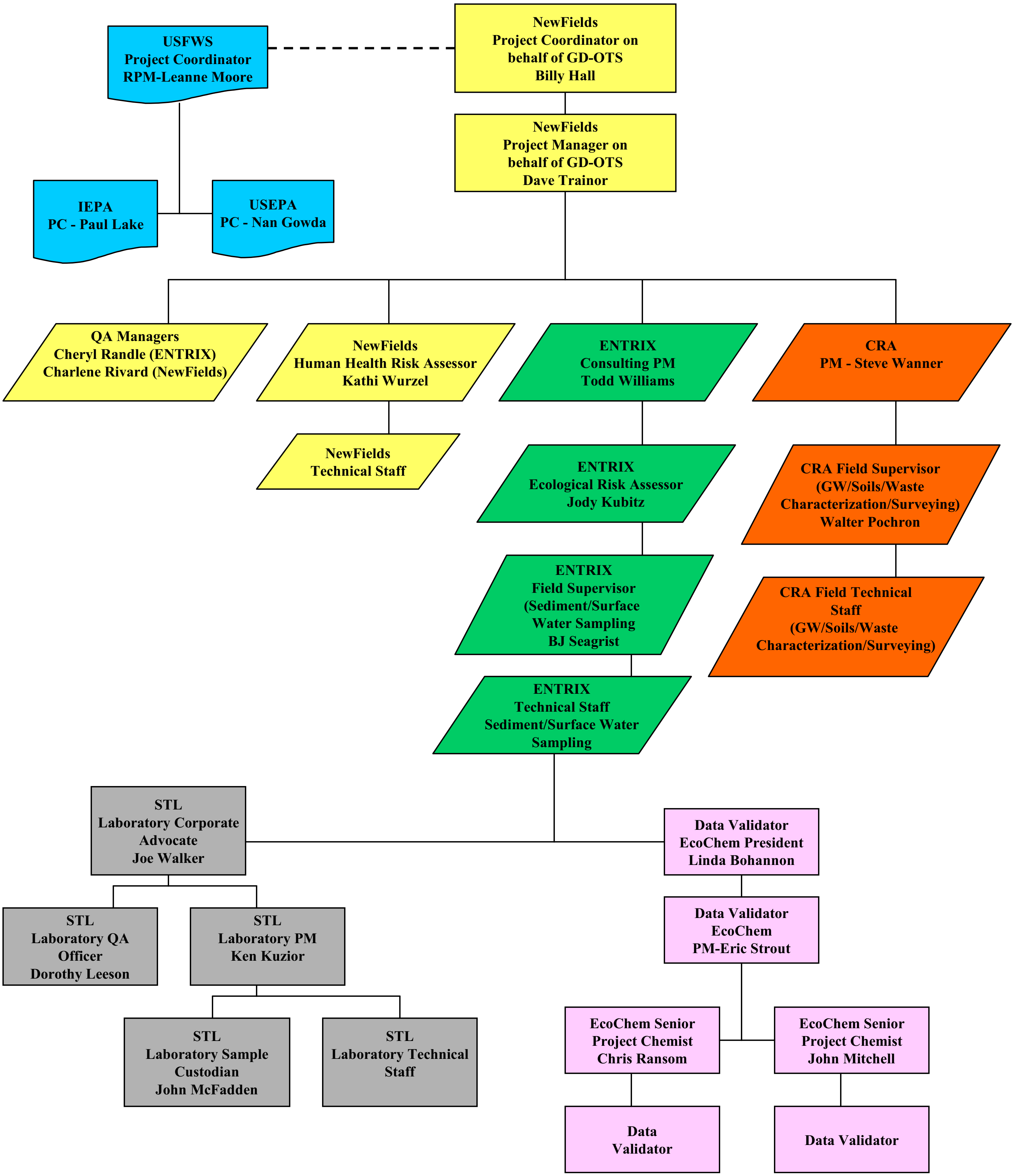

Figure 2.1 - Project Organization Chart

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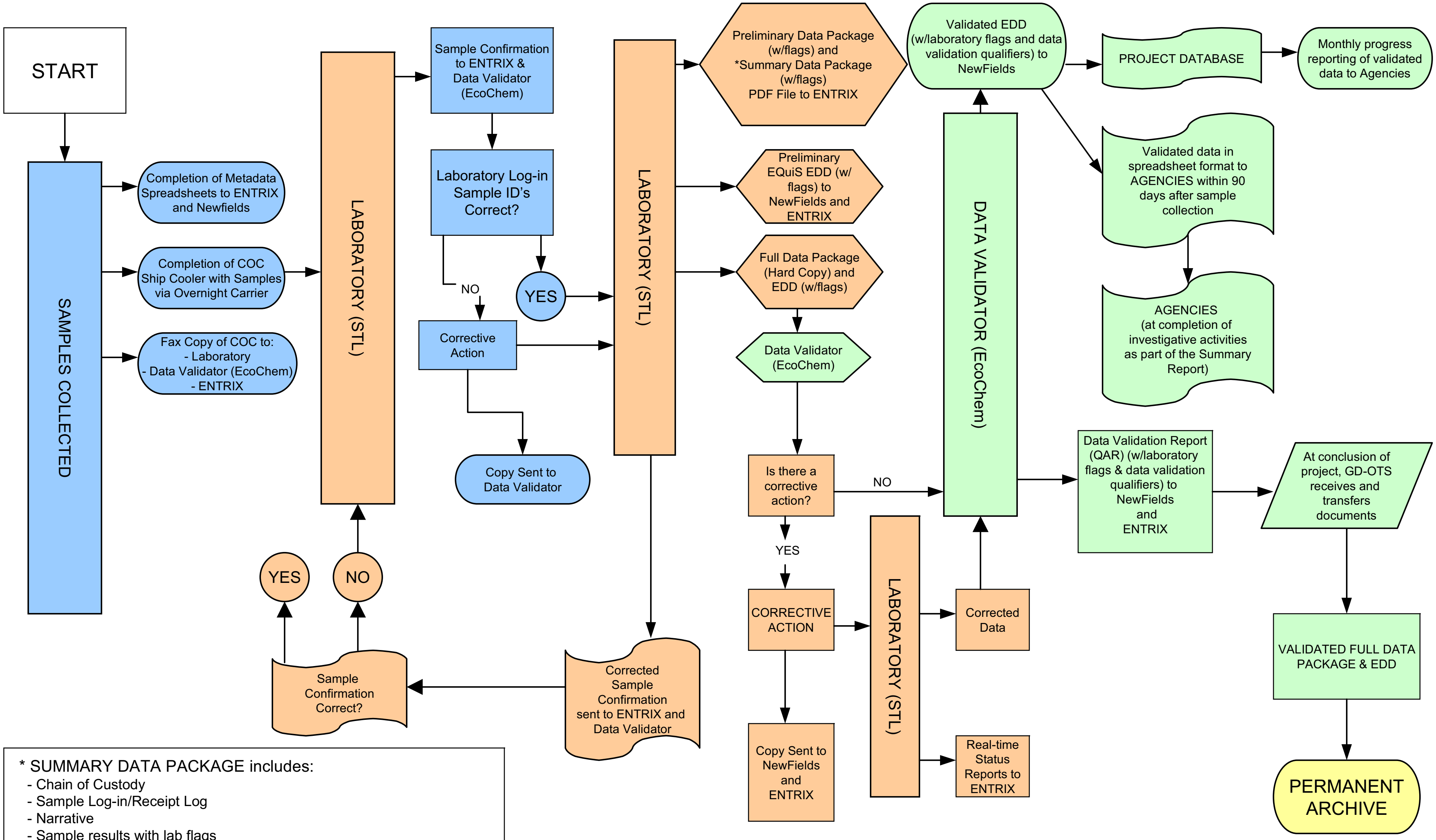

* SUMMARY DATA PACKAGE includes:
- Chain of Custody
- Sample Log-in/Receipt Log
- Narrative
- Sample results with lab flags
- Summary QC
  - method blank report
  - laboratory control sample evaluation
  - matrix spike/matrix spike duplicate evaluation

Figure 9.1
DATA VALIDATION FLOWCHART
CRAB ORCHARD NWR
Rev: 1-25-06

TABLES

Table 1.10
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Semi-Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]Direct Exposure	[2]Indirect Exposure
		(ug/L)	(ug/L)	(ug/L)	(ug/L)
Acenapthene	83-32-9	0.054	0.2	17	NC,b
Acenaphthylene	208-96-8	0.054	0.2	665	NC,b
Acetophenone	98-86-2	0.55	1		NC,b
Anthracene	120-12-7	0.054	0.2	0.035	NCb
Atrazine	1912-24-9	0.65	1	-	-
Benzaldehyde	100-52-7	0.75	1	-	-
Benzenethiol	108-98-5	0.56	10	-	-
Benzedine	92-87-5	0.61	5	-	-
Benzoic Acid	65-85-0	4.4	10	-	-
Benzo(a)anthracene	56-55-3	0.052	0.2	0.027	NC,b
Benzo(a)pyrene	50-32-8	0.048	0.2	0.014	NC,b
Benzo(b)fluoranthene	205-99-2	0.049	0.2	9.07	NC,b
Benzo(k)fluoranthene	207-08-9	0.049	0.2	NA	NC,b
Benzo(g,h,i)perylene	191-24-2	0.053	0.2	7.64	NC,b
Benzyl Alcohol	100-51-6	0.49	5	-	-
Benzyl butyl phthalate	85-68-7	0.51	1	19	NC,b
1,1'Biphenyl	92-52-4	0.55	1	-	-
bis(2-Chloroethoxy)methane	111-91-1	0.49	1	6400	NC,a
bis(2-Chloroethyl)ether	111-44-4	0.088	1	2380	NC,a
bis(2-Ethylhexyl)phthalate	117-81-7	0.88	1	3	NC,b
bis-(2-Chloroisopropyl)ether	108-60-1	0.52	1	-	-
4-Bromophenyl phenyl ether	101-55-3	0.52	2	1.5	NC,b
Caprolactam	105-60-2	0.61	5	-	-
Carbazole	86-74-8	0.54	1	893	NC,b
4-Chloroaniline	106-47-8	0.56	2	2250	NC,a
4-Chloro-3-methylphenol	59-50-7	0.41	2	-	-
2-Chloronaphthalene	91-58-7	0.62	1	310	NC,b
2-Chlorophenol	95-57-8	0.14	1	41	NC,a
4-Chlorophenyl phenyl ether	7005-72-3	0.55	2	46	NC,b
Chrysene	218-01-9	0.048	0.2	16	NC,b

Table 1.10
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Semi-Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]Direct Exposure	[2]Indirect Exposure
		(ug/L)	(ug/L)	(ug/L)	(ug/L)
Dibenz(a,h)acridine	226-36-8	1.7	50	-	-
Dibenz(a,h)anthracene	53-70-3	0.039	0.2	0.0016	NC,b
Dibenzofuran	132-64-9	0.54	1	15	NC,b
3,3'-Dichlorobenzidine	91-94-1	0.48	5	105	NC,b
2,4-Dichlorophenol	120-83-2	1.1	2	-	-
Diethylphthalate	84-66-2	0.63	1	210	NC,a
2,4-Dimethylphenol	105-67-9	0.56	2	-	-
Dimethyl phthalate	99-65-0	0.44	1	330	NC,a
Di-n-butylphthalate	84-74-2	0.61	1	9.4	NC,b
Di-n-octylphthalate	117-84-0	0.39	1	708	NC,b
4,6-Dinitro-2-Methylphenol	534-52-1	0.27	5	2.3	NC,a
2,4-Dinitrophenol	51-28-5	3.5	5	6.2	Nca
2,4-Dinitrotoluene	121-14-2	0.4	5	230	NC,a
2,6-Dinitrotoluene	606-20-2	0.47	5	42	NC,a
1-4 Dioxane	123-91-1	0.46	1	-	-
Fluoranthene	206-44-0	0.036	0.2	8.1	NC,b
Fluorene	86-73-7	0.043	0.2	3.9	NC,b
Hexachlorobenzene	118-74-1	0.065	0.2	3.68	NC,b
Hexachlorobutadiene	87-68-3	0.51	1	0.93	NC,b
Hexachlorocyclopentadiene	77-47-4	0.74	10	0.07	NC,b
Hexachloroethane	67-72-1	0.58	1	9.8	NC,b
Indene	95-13-6	0.8	5	-	-
Indeno(1,2,3-cd)pyrene	193-39-5	0.065	0.2	4.31	NC,b
Isophorone	78-59-1	0.5	1	1170	NC,a
1-Methylnaphthalene	90-12-0	0.048	0.2	-	-
2-Methylnaphthalene	91-57-6	0.061	0.2	12	NC,b
Methylphenol (m-Cresol)	108-39-4	0.63	1	-	-
2-Methylphenol[e] (o-Cresol)	95-48-7	0.56	1	13	NC,a
4-Methylphenol[e] (p-Cresol)	106-44-5	0.64	1	2251	NCa
Naphthalene	91-20-3	0.069	0.2	68	NC,a

Table 1.10
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Semi-Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]Direct Exposure	[2]Indirect Exposure
		(ug/L)	(ug/L)	(ug/L)	(ug/L)
2-Nitroaniline	88-74-4	0.43	2	200	NC,a
3-Nitroaniline	99-09-2	0.67	2	68321	NC,a
4-Nitroaniline	100-01-6	0.47	2	120	NC,a
Nitrobenzene	98-95-3	0.053	1	270	NC,a
2-Nitrophenol	88-75-5	1.3	2	3451	NC,a
4-Nitrophenol	100-02-7	0.63	5	82.8	NC,a
N-Nitro-di-n-propylamine	621-64-7	0.53	1	NA	NC,a
N-Nitrosodimethylamine	62-75-9	0.83	1	-	-
N-Nitrosodiphenylamine	86-30-6	0.46	1	58.5	NC,a
2,2'-Oxybis(1-chloropropane)	108-60-1	0.52	1	NA	NC,a
Pentachlorophenol	87-86-5	0.48	5	15	NC,b
Phenanthrene	85-01-8	0.087	0.2	3.7	NC,b
Phenol	108-95-2	0.96	1	100	NC,a
Pyrene	129-00-0	0.048	0.2	61	NC,b
Pyridine	110-86-1	0.78	1	-	-
Quinoline	91-22-5	1.2	5	-	-
2,4,5-Trichlorphenol	95-95-4	0.96	5	-	-
2,4,6-Trichlorphenol	88-06-2	1.4	5	-	-

ug/L = micrograms per Liter

NA = Not Applicable

NC,a - Ingestion screening value not calculated. Not considered an inqestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

- benchmarks are not available for this compound.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.11
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Metals in a Solid Matrix (Non-Sediment)
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Element	CAS Number	Method	[1]Method Detection Limit (mg/kg)	[1]Reporting Limits (mg/kg)	[2]COPEC Screening Direct (mg/kg)	[2]COPEC Screening Ingestion (mg/kg)
Aluminum	7429-90-5	6010B	5	20	50	NC,a
Antimony	7440-36-0	6010B	0.33	6	5	NC,a
Arsenic	7440-38-2	6010B	0.34	1	9	NC,a
Barium	7440-39-3	6010B	0.2	20	500	NC,a
Beryllium	7440-41-7	6010B	0.029	0.5	10	NC,a
Boron	7440-42-8	6010B	0.65	20	0.5	NC,a
Cadmium	7440-43-9	6010B	0.027	0.5	29	0.27
Calcium	7440-70-2	6010B	8.4	500	NA	Nca
Chromium	7440-47-3	6010B	0.13	1	5	NC,a
Chromium VI	18540-29-9	7196	0.19	0.8	117	NC,a
Cobalt	7440-48-4	6010B	0.34	5	20	NC,a
Copper	7440-50-8	6010B	0.33	2.5	31	NC,a
Iron	7439-89-6	6010B	8.7	10	200	NC,a
Lead	7439-92-1	6010B	0.24	0.3	433	NC,a
Magnesium	7439-95-4	6010B	2.1	500	NA	NC,a
Manganese	7439-96-5	6010B	0.042	1.5	100	NC,a
Mercury	7439-97-6	7471A	0.013	0.1	7	0.15
Nickel	7440-02-0	6010B	0.28	4	30	NC,a
Potassium	7440-09-7	6010B	3.1	500	NA	NC,a
Selenium	7782-49-2	6010B	0.3	0.5	1	1.08
Silver	7440-22-4	6010B	0.29	1	2	NC,a
Sodium	7440-23-5	6010B	33	500	NA	NC,a
Thallium	7440-28-0	6010B	0.53	1	1	NC,a
Vanadium	7440-62-6	6010B	0.097	5	46	NC,a
Zinc	7440-66-6	6010B	0.56	2	120	NC,a
Cyanide	57-12-5	9012A	0.057	0.5	0.9	NC,a

mg/kg - miligrams per kilogram

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.12
Ecological Benchmarks, Method Detection Limits, and Reporting Limits for Metals in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Element	CAS Number	Method	[1]Method Detection Limit	[1]Reporting Limits	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Aluminum	7429-90-5	6010B	5	20	26000	NC,a
Antimony	7440-36-0	6010B	0.33	6	3	NC,a
Arsenic	7440-38-2	6010B	0.34	1	9.79	NC,a
Barium	7440-39-3	6010B	0.2	20	NA	NC,a
Beryllium	7440-41-7	6010B	0.029	0.5	NA	NC,a
Boron	7440-42-8	6010B	0.65	20	NA	NC,a
Cadmium	7440-43-9	6010B	0.027	0.5	0.99	NC,b
Calcium	7440-70-2	6010B	8.4	500	NA	NC,a
Chromium	7440-47-3	6010B	0.13	1	43.4	NC,a
Chromium VI	18540-29-9	7196	0.19	0.8	N/A	NC,a
Cobalt	7440-48-4	6010B	0.34	5	50	NC,a
Copper	7440-50-8	6010B	0.33	2.5	31.6	NC,a
Iron	7439-89-6	6010B	8.7	10	190000	NC,a
Lead	7439-92-1	6010B	0.24	0.3	35.8	NC,a
Magnesium	7439-95-4	6010B	2.1	500	NA	NC,a
Manganese	7439-96-5	6010B	0.042	1.5	630	NC,a
Mercury	7439-97-6	7471A	0.013	0.1	0.18	NC,b
Nickel	7440-02-0	6010B	0.28	4	22.7	NC,a
Potassium	7440-09-7	6010B	3.1	500	NA	NC,a
Selenium	7782-49-2	6010B	0.3	0.5	NA	NC,b
Silver	7440-22-4	6010B	0.29	1	1	NC,a
Sodium	7440-23-5	6010B	33	500	NA	NC,a
Thallium	7440-28-0	6010B	0.53	1	NA	NC,a
Vanadium	7440-62-6	6010B	0.097	5	NA	NC,a
Zinc	7440-66-6	6010B	0.56	2	121	NC,a
Cyanide	57-12-5	9012A	0.057	0.5	0.0001	NC,a

mg/kg - miligrams per kilogram

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.13
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Metals in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Constituents	Cas No.	Method	[1] Method Detection Limit (ug/L)	[1]Reporting Limits (ug/L)	[2]COPEC Screening Direct (ug/L)	[2]COPEC Screening Ingestion (ug/L)
Aluminum	7429-90-5	601B	4.7	200	87	NC,a
Antimony	7440-36-0	601B	4.1	60	30	NC,a
Arsenic	7440-38-2	601B	4.3	10	190	NC,a
Barium	7440-39-3	601B	3.2	200	5000	NC,a
Beryllium	7440-41-7	601B	0.3	5	0.53	NC,a
Boron	7440-42-8	601B	16	200	1000	NC,a
Cadmium	7440-43-9	601B	0.42	5	1.1	NC,b
Calcium	7440-70-2	601B	80	5000	116000	NC,a
Chromium	7440-47-3	601B	1.6	10	210	NC,a
Chromium VI	18540-29-9	7196	4.4	20	NC,a	NC,a
Cobalt	7440-48-4	601B	1.2	50	2.3	NC,a
Copper	7440-50-8	601B	1.8	25	12	NC,a
Cyanide	57-12-5	9012A	1.3	10	NC,a	NC,a
Iron	7439-89-6	601B	32	100	1000	NC,a
Lead	7439-92-1	601B	1.7	3	20	NC,a
Magnesium	7439-95-4	601B	86	5000	82000	NC,a
Manganese	7439-96-5	601B	0.23	15	1000	NC,a
Mercury	7439-97-6	601B	0.09	0.2	1.3	NC,b
Nickel	7440-02-0	601B	1.4	40	1000	NC,a
Potassium	7440-09-7	601B	54	5000	53000	NC,a
Selenium	7782-49-2	601B	2.4	5	1000	NC,a
Silver	7440-22-4	601B	2.1	10	5	NC,b
Sodium	7440-23-5	601B	410	5000	680000	NC,a
Thallium	7440-28-0	601B	4.7	10	4	NC,a
Vanadium	7440-62-6	601B	1.9	50	19	NC,a
Zinc	7440-66-6	601B	6.6	20	1000	NC,a

ug/L - micrograms per Liter

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.14
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Pesticides in Solid (Non-Sediment)
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Pesticides (Method SW846 8081A)	CAS Number	Method Detection Limits[1]	Reporting Limits[1]	COPEC Screening Direct[2]	COPEC Screening Ingestion[2]
		mg/kg	mg/kg	mg/kg	mg/kg
Aldrin	309-00-02	0.0003	0.0017	0	NC,b
alpha-BHC	319-84-6	0.0003	0.0017	0.099	NC,b
beta-BHC	319-85-7	0.0004	0.0017	0	NC,b
delta-BHC	319-86-8	0.00037	0.0017	9.94	NC,b
gamma-BHC (Lindane)	58-89-9	0.00034	0.0017	0.01	NC,b
alpha-Chlordane	5103-71-9	0.00035	0.0017	NA	NC,b
gamma-Chlordane	5103-74-2	0.00031	0.0017	NA	NC,b
Chlordane (technical)	57-74-9	0.0046	0.017	0.224	NC,b
4,4'-DDD	72-54-8	0.0005	0.0017	0.76	NC,b
4,4'-DDE	72-55-9	0.00035	0.0017	0.6	NC,b
4,4'-DDT	50-29-3	0.0004	0.0017	0.0035	NC,b
Dieldrin	60-57-1	0.00034	0.0017	0.002	NC,b
Endosulfan I	959-98-8	0.00033	0.0017	0.119	NC,a
Endosulfan II	33213-65-9	0.00042	0.0017	0.119	NC,a
Endosulfan Sulfate	1031-07-8	0.00038	0.0017	0.036	NC,b
Endrin	72-20-8	0.00034	0.0017	0.01	NC,b
Endrin Aldehyde	7421-93-4	0.00089	0.0017	0.01	NC,b
Endrin Ketone	53494-70-5	0.0007	0.0017	NA	NC,a
Heptachlor	76-44-8	0.00029	0.0017	0.006	NC,b
Heptachlor Epoxide	1024-57-3	0.00042	0.0017	0.15	NC,b
Isodrin	465-73-6	0.0005	0.0033	0.003	NC,b
Methoxychlor	72-43-5	0.00051	0.0033	0.02	NC,b
Toxaphene	8001-35-2	0.031	0.067	0.12	NC,b

mg/kg - milligrams per kilogram

NA - Criteria or Reporting Limit are not available for this element.

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.15
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Pesticides in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Pesticides (Method SW846 8081A)	CAS Number	Method Detection Limits[1]	Reporting Limits[1]	COPEC Screening Direct[2]	COPEC Screening Ingestion[2]
		mg/kg	mg/kg	mg/kg	mg/kg
Aldrin	309-00-02	0.0003	0.0017	0.002	NC,b
alpha-BHC	319-84-6	0.0003	0.0017	0.01	NC,b
beta-BHC	319-85-7	0.0004	0.0017	0.01	NC,b
delta-BHC	319-86-8	0.00037	0.0017	0.03	NC,b
gamma-BHC (Lindane)	58-89-9	0.00034	0.0017	0.002	NC,b
alpha-Chlordane	5103-71-9	0.00035	0.0017	NA	NC,b
gamma-Chlordane	5103-74-2	0.00031	0.0017	NA	NC,b
Chlordane (technical)	57-74-9	0.0046	0.017	0.003	NC,b
4,4'-DDD	72-54-8	0.0005	0.0017	0.005	NC,b
4,4'-DDE	72-55-9	0.00035	0.0017	0.003	NC,b
4,4'-DDT	50-29-3	0.0004	0.0017	0.004	NC,b
Dieldrin	60-57-1	0.00034	0.0017	0.002	NC,b
Endosulfan I	959-98-8	0.00033	0.0017	0.003	NC,a
Endosulfan II	33213-65-9	0.00042	0.0017	0.014	NC,a
Endosulfan Sulfate	1031-07-8	0.00038	0.0017	0.003	NC,b
Endrin	72-20-8	0.00034	0.0017	0.002	NC,b
Endrin Aldehyde	7421-93-4	0.00089	0.0017	0.045	NC,b
Endrin Ketone	53494-70-5	0.0007	0.0017	NA	NC,a
Heptachlor	76-44-8	0.00029	0.0017	0.01	NC,b
Heptachlor Epoxide	1024-57-3	0.00042	0.0017	0.002	NC,b
Isodrin	465-73-6	0.0005	0.0033	0.055	NC,b
Methoxychlor	72-43-5	0.00051	0.0033	0.019	NC,b
Toxaphene	8001-35-2	0.031	0.067	0.028	NC,b

mg/kg - milligrams per kilogram

NA = Criteria or Reporting Limit are not available for this element.

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.16
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Pesticides in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Pesticides (Method SW846 8081A)	CAS Number	Method Detection Limits[1]	Reporting Limits[1]	COPEC Screening Direct[2]	COPEC Screening Ingestion[2]
		ug/L	ug/L	ug/L	ug/L
Aldrin	309-00-02	0.0061	0.05	0.3	NC,b
alpha-BHC	319-84-6	0.0062	0.05	2.2	NC,b
beta-BHC	319-85-7	0.0068	0.05	2.2	NC,b
delta-BHC	319-86-8	0.0064	0.05	2.2	NC,b
gamma-BHC (Lindane)	58-89-9	0.0062	0.05	0.08	NC,b
alpha-Chlordane	5103-71-9	0.0073	0.05	1.09	NC,b
gamma-Chlordane	5103-74-2	0.0065	0.05	1.09	NC,b
Chlordane (technical)	57-74-9	0.075	0.5	0.004	NC,b
4,4'-DDD	72-54-8	0.0085	0.05	0.0064	NC,b
4,4'-DDE	72-55-9	0.0076	0.05	10.5	NC,b
4,4'-DDT	50-29-3	0.0086	0.05	0.001	NC,b
Dieldrin	60-57-1	0.0067	0.05	0.056	NC,b
Endosulfan I	959-98-8	0.0072	0.05	0.056	NC,a
Endosulfan II	33213-65-9	0.0072	0.05	0.056	NC,a
Endosulfan Sulfate	1031-07-8	0.0083	0.05	0.051	NC,b
Endrin	72-20-8	0.0074	0.05	0.036	NC,b
Endrin Aldehyde	7421-93-4	0.0091	0.05	0.033	NC,b
Endrin Ketone	53494-70-5	0.013	0.05	NA	NC,a
Heptachlor	76-44-8	0.0062	0.05	0.004	NC,b
Heptachlor Epoxide	1024-57-3	0.0065	0.05	0.004	NC,b
Isodrin	465-73-6	0.0073	0.1	0.031	NC,b
Methoxychlor	72-43-5	0.01	0.1	0.03	NC,b
Toxaphene	8001-35-2	0.33	2	0.002	NC,b

ug/L - micrograms per liter

NA = Criteria or Reporting Limit are not available for this element.

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.17
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Explosives in Solid (Non-Sediment) and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid:

Explosives (Method SW846 8330)	CAS Number	Method Detection Limits[1] (mg/kg)	Reporting Limits[1] (mg/kg)	COPEC Screening Direct[2] (mg/kg)	COPEC Screening Ingestion[2] (mg/kg)
4-Amino-2,6-dinitrotoluene	19406-51-0	0.02	0.25	NA	NC,a
2-Amino-4,6-dinitrotoluene	35572-78-2	0.1	0.25	80	NC,a
1,3-Dinitrobenzene	99-65-0	0.05	0.25	0.65	NC,a
2,4-Dinitrotoluene	121-14-2	0.02	0.25	1.28	NC,a
2,6-Dinitrotoluene	606-20-2	0.03	0.25	0.033	NC,a
Cyclotetramethylenetetranitramine (HMX)	2691-41-0	0.03	0.25	25	NC,a
Nitrobenzene	98-95-3	0.05	0.25	40	NC,a
Nitroglycerin	55-63-0	0.13	0.5	NA	NC,a
3-Nitrotoluene	99-08-1	0.07	0.25	NA	NC,a
4-Nitrotoluene	99-99-0	0.08	0.25	NA	NC,a
2-Nitrotoluene	88-72-2	0.08	0.25	NA	NC,a
Pentaerythritol Tetranitrate (PETN)	78-11-5	0.16	0.5	N/A	NC,a
Cyclonite (RDX)	121-82-4	0.04	0.25	100	NC,a
Tetryl	479-45-8	0.05	0.25	NA	NC,a
1,3,5-Trinitrobenzene	99-35-4	0.02	0.25	0.38	NC,a
2,4,6-Trinitrotoluene	118-96-7	0.02	0.25	30	NC,a

mg/kg = millograms per kilogram

NA - Not applicable

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.17
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Explosives in Solid (Non-Sediment) and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Water:

Explosives (Method SW846 8330)	CAS Number	Method Detection Limits[1] (ug/L)	Reporting Limits[1] (ug/L)	COPEC Screening Direct[2] (ug/L)	COPEC Screening Ingestion[2] (ug/L)
4-Amino-2,6-dinitrotoluene	19406-51-0	0.05	0.10	540	NC,a
2-Amino-4,6-dinitrotoluene	35572-78-2	0.10	0.20	20	NC,a
1,3-Dinitrobenzene	99-65-0	0.05	1.10	20	NC,a
2,4-Dinitrotoluene	121-14-2	0.05	0.10	230	NC,a
2,6-Dinitrotoluene	606-20-2	0.05	0.10	42	NC,a
Cyclotetramethylenetetranitramine (HMX)	2691-41-0	0.036	0.10	330	NC,a
Nitrobenzene	98-95-3	0.05	0.10	270	NC,a
Nitroglycerin	55-63-0	0.33	0.65	200	NC,a
3-Nitrotoluene	99-08-1	0.057	0.50	8300	NC,a
4-Nitrotoluene	99-99-0	0.088	0.50	7000	NC,a
2-Nitrotoluene	88-72-2	0.088	0.50	7300	NC,a
Pentaerythritol Tetranitrate (PETN)	78-11-5	0.30	0.65	85000	NC,a
Cyclonite (RDX)	121-82-4	0.036	0.10	190	NC,a
Tetryl	479-45-8	0.05	0.10	NA	NC,a
1,3,5-Trinitrobenzene	99-35-4	0.030	0.10	30	NC,a
2,4,6-Trinitrotoluene	118-96-7	0.05	0.10	40	NC,a

ug/L = micrograms per Liter

NA - Not applicable

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.18
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Explosives in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Explosives (Method SW846 8330)	CAS Number	Method Detection Limits[1] (mg/kg)	Reporting Limits[1] (mg/kg)	COPEC Screening Direct[2] (mg/kg)	COPEC Screening Ingestion[2] (mg/kg)
4-Amino-2,6-dinitrotoluene	19406-51-0	0.02	0.25	NA	NC,a
2-Amino-4,6-dinitrotoluene	35572-78-2	0.10	0.25	NA	NC,a
1,3-Dinitrobenzene	99-65-0	0.05	0.25	0.005	NC,a
2,4-Dinitrotoluene	121-14-2	0.02	0.25	0.65	NC,a
2,6-Dinitrotoluene	606-20-2	0.03	0.25	0.09	NC,a
Cyclotetramethylenetetranitramine (HMX)	2691-41-0	0.03	0.25	0.01	NC,a
Nitrobenzene	98-95-3	0.05	0.25	0.59	NC,a
Nitroglycerin	55-63-0	0.13	0.5	0.33	NC,a
3-Nitrotoluene	99-08-1	0.07	0.25	11.87	NC,a
4-Nitrotoluene	99-99-0	0.08	0.25	18.65	NC,a
2-Nitrotoluene	88-72-2	0.08	0.25	16.76	NC,a
Pentaerythritol Tetranitrate (PETN)	78-11-5	0.16	0.5	472	NC,a
Cyclonite (RDX)	121-82-4	0.04	0.25	0.16	NC,a
Tetryl	479-45-8	0.05	0.25	NA	NC,a
1,3,5-Trinitrobenzene	99-35-4	0.02	0.25	0.04	NC,a
2,4,6-Trinitrotoluene	118-96-7	0.02	0.25	0.58	NC,a

mg/kg - millograms per kilogram

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.19
Ecological Benchmarks, Method Detection Limits and Reporting Limits for PCBs in Solid (Non-Sediment), Sediment and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid (Non-Sediment)

PCBs (Method SW846 8082)	CAS Number	Method Detection Limits[1] mg/kg	Reporting limits[1] mg/kg	COPEC Screening Direct[2] mg/kg	COPEC Screening Ingestion[2] mg/kg
Aroclor 1016	12674-11-2	0.011	0.033	NA	NC,b
Aroclor 1221	11104-28-2	0.013	0.033	NA	NC,b
Aroclor 1232	11141-16-5	0.012	0.033	NA	NC,b
Aroclor 1242	53469-21-9	0.014	0.033	NA	NC,b
Aroclor 1248	12672-29-6	0.015	0.033	NA	NC,b
Aroclor 1254	11097-69-1	0.0088	0.033	NA	NC,b
Aroclor 1260	11096-82-5	0.0098	0.033	NA	NC,b
PCBs Total	NA	-	-	40	NC,b

mg/kg - milligrams per kilogram

NA = Criteria or Reporting Limit are not available for this element.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.19
Ecological Benchmarks, Method Detection Limits and Reporting Limits for PCBs in Solid (Non-Sediment), Sediment and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Sediment

PCBs (Method SW846 8082)	CAS Number	Method Detection Limits[1]	Reporting Limits[1]	COPEC Screening Direct[2]	COPEC Screening Ingestion[2]
		mg/kg	mg/kg	mg/kg	mg/kg
Aroclor 1016	12674-11-2	0.011	0.033	0.007	NC,b
Aroclor 1221	11104-28-2	0.013	0.033	0.004	NC,b
Aroclor 1232	11141-16-5	0.012	0.033	NA	NC,b
Aroclor 1242	53469-21-9	0.014	0.033	NA	NC,b
Aroclor 1248	12672-29-6	0.015	0.033	0.03	NC,b
Aroclor 1254	11097-69-1	0.0088	0.033	0.06	NC,b
Aroclor 1260	11096-82-5	0.0098	0.033	0.005	NC,b
PCBs Total	NA	-	-	0.06	NC,b

mg/kg - milligrams per kilogram

NA = Criteria or Reporting Limit are not available for this element.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.19
Ecological Benchmarks, Method Detection Limits and Reporting Limits for PCBs in Solid (Non-Sediment), Sediment and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Water

PCBs (Method SW846 8082)	CAS Number	Method Detection Limits[1]	Reporting limits[1]	COPEC Screening Direct[2]	COPEC Screening Ingestion[2]
		ug/L	ug/L	ug/L	ug/L
Aroclor 1016	12674-11-2	0.25	1	NA	NC,b
Aroclor 1221	11104-28-2	0.49	1	NA	NC,b
Aroclor 1232	11141-16-5	0.41	1	NA	NC,b
Aroclor 1242	53469-21-9	0.11	1	NA	NC,b
Aroclor 1248	12672-29-6	0.049	1	NA	NC,b
Aroclor 1254	11097-69-1	0.087	1	NA	NC,b
Aroclor 1260	11096-82-5	0.071	1	NA	NC,b
PCBs Total	NA	-	-	40	NC,b

ug/L - micrograms per Liter

NA = Criteria or Reporting Limit are not available for this element.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.2
Summary of Sampling and Analysis Program for Phase I
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

SAMPLE MATRIX	FIELD PARAMETERS	SW-846 PREPARATION METHODS	LABORATORY PARAMETERS AND SW-846 METHODS	LABORATORY CONDUCTING ANALYSIS	Sample No.	QC Samples[1]			Total
						Field Duplicates[2]	Equipment Blanks[3]	MS/MSDs[4]	
Surface Water	Dissolved Oxygen, Temperature, pH, ORP, Specific Conductance	3005/7470A	Total TAL Metals+boron (6010B/7470A)	North Canton	265	14	27	14	306
		3005/7470A	Dissolved TAL Metals+boron (6010B/7470A)	North Canton	265	14	27	14	306
		5030A	TCL VOCs (8260B)	North Canton	20	1	2	1	23
		3520	TCL SVOCs (8270C)	North Canton	182	10	19	10	211
		3520	Organochlorine Pesticides (8081A)	North Canton	8	1	1	1	9
		Prep per analytical method	Organophosphorous Pesticides (8141A)	PAL	8	1	1	1	9
		3520	PCBs (8082)	North Canton	0	0	0	0	0
		3520	PAHs (8270C)	North Canton	3	1	1	1	4
		Prep per analytical method	Explosives + Nitroglycerin & PETN (8330)	Sacramento	34	2	2	2	38
		Prep per analytical method	Total Cyanide (9012A)	North Canton	0	0	0	0	0
		Prep per analytical method	Ammonia (350.1)	North Canton	*		NA		
		Prep per analytical method	Nitrate-Nitrite (353.2)	North Canton	0		NA		
		Prep per analytical method	Total Phosphorus-Orthophosphate (365.2)	North Canton	*		NA		
		Prep per analytical method	Methane/Ethane/Ethene (RSK-175)	North Canton	*		NA		
		Prep per analytical method	Sulfide (376.1)	North Canton	*		NA		
		Prep per analytical method	Sulfate (300.0)	North Canton	*		NA		
		Prep per analytical method	Alkalinity (310.1)	North Canton	*		NA		
		Prep per analytical method	TDS (160.1)	North Canton	*		NA		
		Prep per analytical method	Perchlorate (8321A)	Sacramento	191	10	10	10	201
		Prep per analytical method	TSS (160.2)	North Canton	245	13	NA	NA	258
Groundwater	Dissolved Oxygen, Temperature, pH, ORP, Specific Conductance, Turbidity	3005/7470A	Total TAL Metals+boron (6010B/7470A)	North Canton	41	2	4	2	47
		5030A	TCL VOCs (8260B)	North Canton	104	5	11	5	120
		3520	TCL SVOCs (8270C)	North Canton	27	1	2	1	30
		3520	Organochlorine Pesticides (8081A)	North Canton	2	1	1	1	3
		Prep per analytical metod	Organophosphorous Pesticides (8141A)	PAL	2	1	1	1	3
		3520	PCBs (8082)	North Canton	0	0	0	0	0
		3520	PAHs (8270C)	North Canton	6	1	1	1	7
		Prep per analytical method	Explosives + Nitroglycerin & PETN (8330)	Sacramento	38	2	2	2	40
		Prep per analytical method	Total Cyanide (9012A)	North Canton	0	0	0	0	0
		Prep per analytical method	Ammonia (350.1)	North Canton	*		NA		
		Prep per analytical method	Nitrate-Nitrite (353.2)	North Canton	15	1	NA	1	16
		Prep per analytical method	Total Phosphorus-Orthophosphate (365.2)	North Canton	*		NA		
		Prep per analytical method	Methane/Ethane/Ethene (RSK-175)	North Canton	*				
		Prep per analytical method	Sulfide (376.1)	North Canton	*				
		Prep per analytical method	Sulfate (300.0)	North Canton	16	1	NA	1	17
		Prep per analytical method	Alkalinity (310.1)	North Canton	*		NA		
		Prep per analytical method	TDS (160.1)	North Canton	*		NA		
		Prep per analytical method	Perchlorate (8321A)	Sacramento	94	5	5	5	99
		Prep per analytical method	TSS (160.2)	North Canton	*		NA	NA	

Table 1.2
Summary of Sampling and Analysis Program for Phase I
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

SAMPLE MATRIX	FIELD PARAMETERS		LABORATORY PARAMETERS		Sample No.	QC Samples[1]			Total
						Field Duplicates[2]	Equipment Blanks[3]	MS/MSDs[5]	
Sediment	NA	3005/7471A	TAL Metals (total)+boron (6010B/7471A)	North Canton	191	10	10	10	211
		3550	TCL SVOCs (8270C)	North Canton	167	9	9	9	165
		5020A	TCL VOCs (8260B)	North Canton	20	1	1	1	22
		3550	Organochlorine Pesticides (8081A)	North Canton	8	1	1	1	10
		Prep per analytical method	Organophosphorous Pesticides (8141A)	PAL	8	1	1	1	10
		3550	PCBs (8082)	North Canton	0	0	0	0	0
		3550	PAHs (8270C)	North Canton	6	1	1	1	8
		Prep per analytical method	Explosives + Nitroglycerin & PETN (8330)	Sacramento	23	2	2	2	27
		Prep per analytical method	Total Cyanide (9012A)	North Canton	0	0	0	0	0
		Prep per analytical method	Alkalinity (310.1)	North Canton	*				
		Prep per analytical method	TOC (Walkley-Black)	North Canton	*			NA	
		Prep per analytical method	pH (9045C)	North Canton	0	NA	NA	NA	0
Surface and Subsurface Soils (combined)	Soil gas screening using PID	3005/7471A	TAL Metals (total)+boron (6010B/7471A)	North Canton	2191	111	111	111	2413
		5035	TCL VOCs (8260B)	North Canton	762	39	39	39	845
		3500	TCL SVOCs (8270C)	North Canton	738	38	38	38	814
		3550	Pentachlorophenol (8270)	North Canton	8	1	1	1	10
		3550	Organochlorine Pesticides (8081A)	North Canton	106	6	6	6	118
		Prep per analytical method	Organophosphorous Pesticides (8141A)	PAL	106	6	6	6	118
		3550	PCBs (8082)	North Canton	60	3	3	3	66
		3550	PAHs (8270C)	North Canton	850	43	43	43	936
		Prep per analytical method	Explosives + Nitroglycerin & PETN (8330)	Sacramento	787	40	40	40	867
		Prep per analytical method	Total Cyanide (9012A)	North Canton	36	2	2	2	40
			Nitrates (9210 or 9056)	North Canton	32	2	2	2	36
			Perchlorate (Modified 8321A)	Sacramento	10	1	1	1	12
			Total Phosphorous/Orthophosphate (365.2)	North Canton	8	1	1	1	10
			Sulfates (9056 or 9038)	North Canton	28	2	2	2	32
			Dioxin/Furans (8280)	Sacramento	4	1	1	1	7
		Prep per analytical method	Alkalinity (310.1)	North Canton	*				
		Prep per analytical method	TOC (Walkley-Black)	North Canton	*				
		Prep per analytical method	pH (9045C)	North Canton	50	NA			50
		Prep per analytical method	Grain Size (ASTM D422)	Burlington	10	NA			10
		Prep per analytical method	Permeability (ASTM D5084-90)	Burlington	10	NA			10

Notes:

[1] One Trip Blank Sample (2 vials) will be shipped with each cooler containing aqueous samples submitted for VOC analysis.

[2] At a minimum, field duplicates will be collected at a frequency of 1 for every 20 investigative samples or 5%.

[3] At a minimum, equipment blanks will be collected at a frequency of 1 for every 10 aqueous investigative samples or 10% and 1 for every 20 solid investigative sample or 5%.

[4] At a minimum, MS/MSDs will be collected at a frequency of 1 for every 20 investigative samples or 5%.

NA = Not Applicable

* To Be Determined in Phase II.

Table 1.20
Ecological Benchmarks, Method Detections Limit and Reporting Limits for Dioxins in Solid (Non-Sediment), Sediment and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid (Non-Sediment)

Constituent (Method SW846 8290)	CAS Number	[1]Method Detection Limits (mg/kg)	[1]Reporting Limits (mg/kg)	[2]COPEC Screening Direct (mg/kg)	[2]COPEC Screening Ingestion (mg/kg)
2,3,7,8-TCDD	1746-01-6	0.0000005	0.000001	5	0.000000805

Sediment

Constituent (Method SW846 8290)	CAS Number	[1]Method Detection Limits (mg/kg)	[1]Reporting Limits (mg/kg)	[2]COPEC Screening Direct (mg/kg)	[2]COPEC Screening Ingestion (mg/kg)
2,3,7,8-TCDD	1746-01-6	0.0000005	0.000001	NA	NC,b

Aqueous

Constituent (Method SW846 8290)	CAS Number	[1]Method Detection Limits (ug/L)	[1]Reporting Limits (ug/L)	[2]COPEC Screening Direct (ug/L)	[2]COPEC Screening Ingestion (ug/L)
2,3,7,8-TCDD	1746-01-6	0.000005	0.00001	NA	NC,b

mg/kg - milligrams per kilogram

ug/L = micrograms per kilogram

NA - Not applicable

NC,b - Ingestion screening value is not calculated, however, is automatically considered a COPEC if decided based upon bioaccumulation potential.

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.21
Ecological Benchmarks, Method Detection Limit and Reporting Limit for Perchlorate in Solid (Non-Sediment), Sediment, and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Aqueous:

Constituent (SW846 8321A)	CAS Number	Method Detection Limits[1] ug/L	Reporting Limits[1] ug/L	COPEC Screening Direct[2] ug/L	COPEC Screening Ingestion[2] ug/L
Perchlorate	14-97-73-0	0.092	0.5	-	NC,a

ug/L - micrograms per liter

Solid (Non-Sediment):

Constituent (SW846 8321A)	CAS Number	Method Detection Limits[1] ug/kg	Reporting Limits[1] ug/kg	COPEC Screening Direct[2] ug/kg	COPEC Screening Ingestion[2] ug/kg
Perchlorate	14-97-73-0	0.216	1.0	-	NC,a

ug/kg - micrograms per kilogram

Sediment:

Constituent (SW846 8321A)	CAS Number	Method Detection Limits[1] ug/kg	Reporting Limits[1] ug/kg	COPEC Screening Direct[2] ug/kg	COPEC Screening Ingestion[2] ug/kg
Perchlorate	14-97-73-0	0.216	1.0	-	NC,a

ug/kg - micrograms per kilogram

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1-3
Method Detection and Reporting Limits for Methane, Ethane, and Ethene Analyses in Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Aqueous:

Miscellaneous	Units	Method Detection Limits[1]	Reporting limits[1]
Ethane	ug/L	0.16	0.5
Ethene	ug/L	0.16	0.5
Methane	ug/L	0.11	0.5

ug/L = micrograms per Liter

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results

Table 1-4
Method Detection and Reporting Limits for Miscellaneous Inorganic Analyses in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid:

General Chemistry	Units	Method Detection Limits[1]	Reporting Limits[1]
Total Alkalinity	mg/kg	100.0	100.0
pH (solid)	No Units	NA	NA
Total Organic Carbon	mg/kg	100.0	100.0

Aqueous:

General Chemistry	Units	Method Detection Limits[1]	Reporting Limits[1]
Total Alkalinity	mg/L	1.3	5.0
Total Suspended Solids	mg/L	2.8	4.0
Total Dissolved Solids	mg/L	4.3	10.
Nitrogen, as Ammonia	mg/L	0.034	0.2
Nitrate/Nitrite as N	mg/L	0.026	0.1
Total Phosphorus/Orthophosphate	mg/L	0.033	0.1
Total Sulfide	mg/L	0.25	1.0
Sulfate	mg/L	0.18	5.0

mg/kg = miligrams per kilograms
mg/L = miligrams per Liter

[1] Method Detection Limits and Reporting Limits based on Severn Trent Laboratories results

Table 1.5
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in a Solid Matrix (Non-Sediment)
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW846 8260)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Acetone	67-64-1	0.0058	0.02	2.5	NC,a
Benzene	71-43-2	0.00069	0.005	16	NC,a
Bromobenzene	108-86-1	0.0011	0.005	-	-
Bromodichloromethane	75-27-4	0.007	0.005	0.54	NC,a
Bromoform	75-25-2	0.00072	0.005	15.9	NC,a
Bromomethane	74-83-9	0.0014	0.005	0.24	NC,a
n-Butlybenzene	104-51-8	0.0013	0.005	-	-
sec-Butlybenzene	135-98-8	0.0013	0.005	-	-
tert-Butlybenzene	98-06-6	0.0013	0.005	-	-
2-Butanone	78-93-3	0.0027	0.02	89.6	NC,a
Carbon disulfide	75-15-0	0.001	0.005	-	-
Carbon tetrachloride	56-23-5	0.00064	0.005	1000	NC,a
Chlorobenzene	108-90-7	0.0011	0.005	40	NC,a
Chloroethane	75-00-3	0.0014	0.005	NA	NC,a
Chloroform	67-66-3	0.00071	0.005	1.19	NC,a
Chloromethane	74-87-3	0.00091	0.005	10.4	NC,a
Cyclohexane	110-82-7	0.00078	0.01	-	-
Dibromochloromethane	124-48-1	0.0006	0.005	2.05	NC,a
1,2-Dibromo-3-chloropropane	96-12-8	0.0011	0.01	-	-
1,2-Dibromoethane	106-93-4	0.00082	0.005	-	-
1,2-Dichlorobenzene	95-50-1	0.0014	0.005	2.96	NC,a
1,3-Dichlorobenzene	541-73-1	0.0014	0.005	37.7	NC,b
1,4-Dichlorobenzene	106-46-7	0.0015	0.005	20	NC,a
Dichlorodifluoromethane	75-71-8	0.00094	0.005	-	-
1,1-Dichloroethane	75-34-3	0.00067	0.005	20.1	NC,a
1,2-Dichloroethane	107-06-2	0.0006	0.005	21.2	NC,a
1,1-Dichloroethene	75-35-4	0.00081	0.005	8.28	NC,a
cis-1,2-Dichloroethene	156-59-4	0.00091	0.0025	NA	NC,a
trans-1,2-Dichloroethene	156-60-5	0.00076	0.0025	0.79	NC,a
1,2-Dichloropropane	78-87-5	0.00062	0.005	700	NC,a

Table 1.5
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in a Solid Matrix (Non-Sediment)
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW846 8260)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
1,3-Dichloropropene	542-75-6	*	*	NA	NC,a
cis-1,3-Dichloropropene	10061-01-5	0.00063	0.005	0.4	NC,a
trans-1,3-Dichloropropene	10061-02-6	0.00066	0.005	0.4	NC,a
Ethylbenzene	100-41-4	0.0012	0.005	5	NC,a
2-Hexanone	591-78-6	0.0015	0.02	12.6	NC,a
Isopropylbenzene	98-82-8	0.0012	0.005	-	-
p-Isopropyltoluene	99-87-6	0.0014	0.005	-	-
Methyl acetate	79-20-9	0.0049	0.01	-	-
Methylene chloride	75-09-2	0.0012	0.005	4.05	Nca
Methylcyclohexane	108-87-2	0.00056	0.01	-	-
4-Methyl-2-pentanone	108-10-1	0.0016	0.02	443	NC,a
Methyl tert-butyl ether	1634-04-4	0.00067	0.02	-	-
n-Propylbenzene	103-65-1	0.0013	0.005	-	-
Styrene	100-42-5	0.0011	0.005	300	NC,a
1,1,1,2-Tetrachloroethane	630-2-06	0.00079	0.005	-	-
1,1,2,2-Tetrachloroethane	79-34-5	0.00083	0.005	0.13	-
Tetrachloroethene	127-18-4	0.0012	0.005	13	NC,a
Toluene	108-88-3	0.00072	0.005	34	NC,a
1,2,3-Trichlorobenzene	87-61-6	0.001	0.005	-	-
1,2,4-Trichlorobenzene	120-82-1	0.0012	0.005	20	NC,b
1,1,1-Trichloroethane	71-55-6	0.00069	0.005	29.8	NCa
1,1,2-Trichloroethane	79-00-5	0.0005	0.005	28.6	NCa
Trichloroethene	79-01-6	0.0008	0.005	9	NC,a
Trichlorofluoromethane	75-69-4	0.0011	0.005	-	-
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.00098	0.005	-	-
1,2,3-Trichloropropane	96-18-4	0.00053	0.005	-	-
1,2,4-Trimethylbenzene	95-63-6	0.0012	0.005	-	-
1,3,5-Trimethylbenzene	108-67-8	0.0015	0.005	-	-
Vinyl chloride	75-01-4	0.0012	0.005	0.65	NC,a
Xylenes	95-47-6	0.0038	0.01	0.6	NC,a

mg/kg - milligrams per kilogram

Table 1.5
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in a Solid Matrix (Non-Sediment)
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW846 8260)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value is not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

* = Severn Trent Laboratories reports 1,3-Dichloropropene as *cis* and *trans.* 1,3-Dichloropropene (total) is not reported.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

"-" denotes that benchmarks are not available for this compound.

Table 1.6
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW 846 8260)	**CAS Number**	**[1]Method Detection Limit**	**[1]Reporting Limit**	**[2]COPEC Screening Direct**	**[2]COPEC Screening Ingestion**
		(mg/kg)	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
Acetone	67-64-1	0.0058	0.02	0.08	NC,a
Benzene	71-43-2	0.00069	0.005	0.06	NC,a
Bromobenzene	108-86-1	0.0011	0.005	-	-
Bromodichloromethane	75-27-4	0.0007	0.005	17.50	NC,a
Bromoform	75-25-2	0.00072	0.005	1.25	NC,a
Bromomethane	74-83-9	0.0014	0.005	10.50	NC,a
n-Butlybenzene	104-51-8	0.0013	0.005	-	-
sec-Butlybenzene	135-98-8	0.0013	0.005	-	-
tert-Butlybenzene	98-06-6	0.0013	0.005	-	-
2-Butanone	78-93-3	0.0027	0.02	4.4	NC,a
Carbon disulfide	75-15-0	0.001	0.005	-	-
Carbon tetrachloride	56-23-5	0.00064	0.005	0.08	NC,a
Chlorobenzene	108-90-7	0.0011	0.005	0.82	NC,a
Chloroethane	75-00-3	0.0014	0.005	14.5	NC,a
Chloroform	67-66-3	0.00071	0.005	0.07	NC,a
Chloromethane	74-87-3	0.00091	0.005	47.8	NC,a
Cyclohexane	110-82-7	0.00078	0.01	-	NC,a
Dibromochloromethane	124-48-1	0.0006	0.005	30.8	NC,a
1,2-Dibromo-3-chloropropane	96-12-8	0.0011	0.01	-	-
1,2-Dibromoethane	106-93-4	0.00082	0.005	-	-
1,2-Dichlorobenzene	95-50-1	0.0014	0.005	0.34	NC,a
1,3-Dichlorobenzene	541-73-1	0.0014	0.005	1.7	NC,b
1,4-Dichlorobenzene	106-46-7	0.0015	0.005	0.35	NC,a
Dichlorodifluoromethane	75-71-8	0.00094	0.005	-	-
1,1-Dichloroethane	75-34-3	0.00067	0.005	0.09	NC,a
1,2-Dichloroethane	107-06-2	0.0006	0.005	1.23	NC,a
1,1-Dichloroethene	75-35-4	0.00081	0.005	0.11	NC,a

Table 1.6
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW 846 8260)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
cis-1,2-Dichloroethene	156-59-4	0.00091	0.005	1.18	NC,a
trans-1,2-Dichloroethene	156-60-5	0.00076	0.005	1.18	NC,a
1,2-Dichloropropane	78-87-5	0.00062	0.005	1.38	NC,a
1,3-Dichloropropene	542-75-6	*	*	NA	NC,a
cis-1,3-Dichloropropene	10061-01-5	0.00063	0.005	0.0002	NC,a
trans-1,3-Dichloropropene	10061-02-6	0.00066	0.005	0.05	NC,a
Ethylbenzene	100-41-4	0.0012	0.005	3.6	NC,a
2-Hexanone	591-78-6	0.0015	0.02	0.13	NC,a
Isopropylbenzene	98-82-8	0.0012	0.005	-	-
p-Isopropyltoluene	99-87-6	0.0014	0.005	-	-
Methyl acetate	79-20-9	0.0049	0.01	-	-
Methylene chloride	75-09-2	0.0012	0.005	0.92	NC,a
Methylcyclohexane	108-87-2	0.00056	0.001	-	-
4-Methyl-2-pentanone	108-10-1	0.0016	0.02	0.21	NC,a
Methyl tert-butyl ether	1634-04-4	0.00067	0.02	-	-
n-Propylbenzene	103-65-1	0.0013	0.005	-	-
Styrene	100-42-5	0.0011	0.005	21.6	NC,a
1,1,1,2-Tetrachloroethane	630-20-6	0.00079	0.005	-	-
1,1,2,2-Tetrachloroethane	79-34-5	0.00083	0.005	0.94	NC,a
Tetrachloroethene	127-18-4	0.0012	0.005	0.53	NC,a
Toluene	108-88-3	0.00072	0.005	0.67	NC,a
1,2,3-Trichlorobenzene	87-61-6	0.001	0.005	-	-
1,2,4-Trichlorobenzene	120-82-1	0.0012	0.005	9.2	NC,b
1,1,1-Trichloroethane	71-55-6	0.00069	0.005	0.17	NC,a
1,1,2-Trichloroethane	79-00-5	0.0005	0.005	1.06	NC,a
Trichloroethene	79-01-6	0.0008	0.005	1.6	NC,a
Trichlorofluoromethane	75-69-4	0.0011	0.005	-	-

Table 1.6
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW 846 8260)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.00098	0.005	-	-
1,2,3-Trichloropropane	96-18-4	0.00053	0.005	-	-
1,2,4-Trimethylbenzene	95-63-6	0.0012	0.005	-	-
1,3,5-Trimethylbenzene	108-67-8	0.0015	0.005	-	-
Vinyl chloride	75-01-4	0.0012	0.005	26.4	NC,a
Xylenes	95-47-6	0.0038	0.01	0.03	NC,a

mg/kg - milligrams per kilogram

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value is not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

* - Severn Trent Laboratories reports 1,3-Dichloropropene as *cis* and *trans.* STL does not report 1,3-Dichloropropene as (total).

"-" denotes that benchmarks are not available for this compound.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.7
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW846 8260)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(ug/L)	(ug/L)	(ug/L)	(ug/L)
Acetone	67-64-1	0.74	10	507	NC,a
Benzene	71-43-2	0.22	1	46	NC,a
Bromodichloromethane	75-27-4	0.14	1	15215	NC,a
Bromoform	75-25-2	0.17	1	293	NC,a
Bromobenzene	108-86-1	0.19	1	-	-
Bromomethane	74-83-9	0.36	1	67647	NCa
n-Butylbenzene	104-51-8	0.2	1	-	-
sec-Butlybenzene	135-98-8	0.15	1	-	-
tert-Butlybenzene	98-06-6	0.14	1	-	-
2-Butanone	78-93-3	0.39	10	14000	NC,a
Carbon disulfide	75-15-0	0.28	1	-	-
Carbon tetrachloride	56-23-5	0.19	1	9.8	NC,a
Chlorobenzene	108-90-7	0.2	1	64	NC,a
Chloroethane	75-00-3	0.24	1	21069	NC,a
Chloroform	67-66-3	0.16	1	28	NC,a
Chloromethane	74-87-3	0.14	1	67467	NC,a
Cyclohexane	110-82-7	0.12	1	-	-
Dibromochloromethane	124-48-1	0.19	1	14607	NC,a
1,2-Dibromo-3-chloropropane	96-12-8	0.28	2	-	-
1,2-Dibromoethane	106-93-4	0.24	1	-	-
1,2-Dichlorobenzene	95-50-1	0.2	1	170	NC,a
1,3-Dichlorobenzene	541-73-1	0.18	1	50.2	NC,b
1,4-Dichlorobenzene	106-46-7	0.22	1	11.2	NC,a
Dichlorodifluoromethane	75-71-8	0.25	1	-	-
1,1-Dichloroethane	75-34-3	0.21	1	47	NC,a
1,2-Dichloroethane	107-06-2	0.16	1	910	NC,a
1,1-Dichloroethene	75-35-4	0.18	1	25	NC,a

Table 1.7
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW846 8260)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(ug/L)	(ug/L)	(ug/L)	(ug/L)
cis-1,2-Dichloroethene	156-59-4	0.21	1	1100	NC,a
trans-1,2-Dichloroethene	156-60-5	0.16	1	1100	NC,a
1,2-Dichloropropane	78-87-5	0.15	1	-	-
1,3-Dichloropropene	542-75-6	*	*	NA	NC,a
cis-1,3-Dichloropropene	10061-01-5	0.12	1	0.055	NC,a
trans-1,3-Dichloropropene	10061-02-6	0.17	1	24.4	NC,a
Ethylbenzene	100-41-4	0.19	1	7.3	NC,a
2-Hexanone	591-78-6	0.35	10	99	NC,a
Isopropylbenzene	98-82-8	0.15	1	-	-
p-Isopropyltoluene	99-87-6	0.17	1	-	-
Methyl acetate	79-20-9	0.52	10	-	-
Methylene chloride	75-09-2	0.19	1	1930	NC,a
Methylcyclohexane	108-87-2	0.5	1	-	-
4-Methyl-2-pentanone	108-10-1	0.32	10	170	NC,a
Methyl tert-butyl ether	1634-04-4	0.18	5	-	-
n-Propylbenzene	103-65-1	0.17	1	-	-
Styrene	100-42-5	0.13	1	4020	NC,a
1,1,1,2-Tetrachloroethane	630-2-06	0.12	1	-	-
1,1,2,2-Tetrachloroethane	79-34-5	0.22	1	240	NC,a
Tetrachloroethene	127-18-4	0.19	1	150	NC,a
Toluene	108-88-3	0.17	1	110	NC,a
1,2,3-Trichlorobenzene	87-61-6	0.18	1	-	-
1,2,4-Trichlorobenzene	120-82-1	0.19	1	44.9	NC,b
1,1,1-Trichloroethane	71-55-6	0.21	1	11	NC,a
1,1,2-Trichloroethane	79-00-5	0.22	1	940	NC,a
Trichloroethene	79-01-6	0.28	1	940	NC,a
Trichlorofluoromethane	75-69-4	0.16	1	-	-

Table 1.7
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Volatiles (Method SW846 8260)	**CAS Number**	**[1]Method Detection Limit**	**[1]Reporting Limit**	**[2]COPEC Screening Direct**	**[2]COPEC Screening Ingestion**
		(ug/L)	**(ug/L)**	**(ug/L)**	**(ug/L)**
1,2,3-Trichloropropane	96-18-4	0.36	1	-	-
1,2,4-Trimethylbenzene	95-63-6	0.12	1	-	-
1,3,5-Trimethylbenzene	108-67-8	0.16	1	-	-
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	0.26	1	-	-
Vinyl chloride	75-01-4	0.21	1	4000	NC,a
Xylenes	95-47-6	0.44	2	120	NC,a

ug/L = micrograms per Liter

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

* = Severn Trent Laboratories does not provide information for 1,3-Dichloropropene (total), instead information is provided as *cis* and *trans.*

\- benchmarks are not available for this compound.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.8
Ecological Benchmarks, Method Detection Limits, and Reporting Limits for Semi-Volatiles in a Solid Matrix (Non-Sediment)
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Acenapthene	83-32-9	0.00092	0.00667	8.300	222.000
Acenaphthylene	208-96-8	0.0014	0.00667	8.300	NC,b
Acetophenone	98-86-2	0.0055	0.1	-	NC,a
Anthracene	120-12-7	0.0023	0.00667	10.000	1271.000
Atrazine	1912-24-9	0.011	0.2	-	NC,a
Benzaldehyde	100-52-7	0.0069	0.1	-	NC,a
Benzedine	92-87-5	0.055	0.33	-	NC,a
Benzenethiol	108-98-5	0.042	0.33	-	NC,a
Benzoic Acid	65-85-0	0.042	0.66	-	NC,a
Benzo(a)anthracene	56-55-3	0.0014	0.00667	3.000	180.000
Benzo(a)pyrene	50-32-8	0.0023	0.00667	3.300	100.000
Benzo(b)fluoranthene	205-99-2	0.0023	0.00667	1.200	100.000
Benzo(k)fluoranthene	207-08-9	0.0023	0.00667	148.000	90.000
Benzo(g,h,i)perylene	191-24-2	0.0018	0.00667	119.000	100.000
Benzyl Alcohol	100-51-6	0.14	0.33	-	NC,b
Benzyl butyl phthalate	85-68-7	0.0037	0.05	0.240	860.000
1,1'Biphenyl	92-52-4	0.0072	0.05	-	NC,a
bis(2-Chloroethoxy)methane	111-91-1	0.016	0.1	0.300	NC,a
bis(2-Chloroethyl)ether	111-44-4	0.0041	0.1	23.700	NC,a
bis(2-Ethylhexyl)phthalate	117-81-7	0.016	0.05	1.000	4.420
bis-(2-Chloroisopropyl)ether	108-60-1	0.0052	0.1	-	NC,b
4-Bromophenyl phenyl ether	101-55-3	0.0047	0.05	NA	NC,b
Caprolactam	105-60-2	0.0078	0.33	-	NC,b
Carbazole	86-74-8	0.0093	0.05	NA	12.710
4-Chloroaniline	106-47-8	0.0052	0.15	1.100	NC,a
4-Chloro-3-methylphenol	59-50-7	0.051	0.15	7.950	NC,a
2-Chloronaphthalene	91-58-7	0.0063	0.05	0.012	NC,b
2-Chlorophenol	95-57-8	0.0036	0.05	0.240	NC,a
4-Chlorophenyl phenyl ether	7005-72-3	0.0036	0.05	NA	NC,b
Chrysene	218-01-9	0.00099	0.00667	4.700	150.000

Table 1.8
Ecological Benchmarks, Method Detection Limits, and Reporting Limits for Semi-Volatiles in a Solid Matrix (Non-Sediment)
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit (mg/kg)	[1]Reporting Limit (mg/kg)	[2]COPEC Screening Direct (mg/kg)	[2]COPEC Screening Ingestion (mg/kg)
Dibenz(a,h)acridine	226-36-8	0.064	0.33	-	NC,b
Dibenz(a,h)anthracene	53-70-3	0.0015	0.00667	18.400	100.000
Dibenzofuran	132-64-9	0.00083	0.05	NA	25.400
3,3'-Dichlorobenzidine	91-94-1	0.0049	0.1	0.650	NC,b
2,4-Dichlorophenol	120-83-2	0.0053	0.15	87.500	NC,a
Diethylphthalate	84-66-2	0.0062	0.05	100.000	NC,a
2,4-Dimethylphenol	105-67-9	0.0068	0.15	0.010	NC,a
Dimethyl phthalate	99-65-0	0.0064	0.05	200.000	NC,a
Di-n-butylphthalate	84-74-2	0.005	0.05	200.000	0.710
Di-n-octylphthalate	117-84-0	0.011	0.05	709.000	610.000
4,6-Dinitro-2-Methylphenol	534-52-1	0.047	0.15	NA	NC,a
2,4-Dinitrophenol	51-28-5	0.041	0.33	20.000	NC,a
2,4-Dinitrotoluene	121-14-2	0.0057	0.2	1.280	NC,a
2,6-Dinitrotoluene	606-20-2	0.0058	0.2	0.033	NC,a
1,4 Dioxane	123-91-1	0.13	0.1	-	-
Fluoranthene	206-44-0	0.0093	0.00667	100.000	159.000
Fluorene	86-73-7	0.0013	0.00667	22.000	159.000
Hexachlorobenzene	118-74-1	0.0014	0.00667	1000.000	NC,b
Hexachlorobutadiene	87-68-3	0.0025	0.05	0.040	NC,b
Hexachlorocyclopentadiene	77-47-4	0.0029	0.33	10.000	NC,b
Hexachloroethane	67-72-1	0.0049	0.05	0.600	NC,b
Indene	95-13-6	0.097	0.33	-	NC,b
Indeno(1,2,3-cd)pyrene	193-39-5	0.002	0.00667	109.000	90.000
Isophorone	78-59-1	0.0035	0.05	139.000	NC,a
1-Methylnaphthalene	90-12-0	0.0012	0.00667	-	NC,b
2-Methylnaphthalene	91-57-6	0.00099	0.00667	249.000	45.800
Methylphenol (m-Cresol)	108-39-4	0.0043	0.2	-	NC,a
2-Methylphenol (o-Cresol)	95-48-7	0.0067	0.2	40.400	NC,a
4-Methylphenol (p-Cresol)	106-44-5	0.0058	0.2	163.000	NC,a
Naphthalene	91-20-3	0.00089	0.00667	249.000	45.800

Table 1.8
Ecological Benchmarks, Method Detection Limits, and Reporting Limits for Semi-Volatiles in a Solid Matrix (Non-Sediment)
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit (mg/kg)	[1]Reporting Limit (mg/kg)	[2]COPEC Screening Direct (mg/kg)	[2]COPEC Screening Ingestion (mg/kg)
2-Nitroaniline	88-74-4	0.0051	0.2	74.100	NC,a
3-Nitroaniline	99-09-2	0.0032	0.2	3.160	NC,a
4-Nitroaniline	100-01-6	0.0036	0.2	21.900	NC,a
Nitrobenzene	98-95-3	0.0064	0.1	40.000	NC,a
2-Nitrophenol	88-75-5	0.0034	0.05	1.600	NC,a
4-Nitrophenol	100-02-7	0.081	0.33	7.000	NC,a
N-Nitro-di-n-propylamine	621-64-7	0.0076	0.05	0.540	NC,a
N-Nitrosodimethylamine	62-75-9	0.0054	0.1	-	NC,a
N-Nitrosodiphenylamine	86-30-6	0.0041	0.05	20.000	NC,a
2, 2'-Oxybis(1-chloropropane)	108-60-1	0.0052	0.1	NA	NC,a
Pentachlorophenol	87-86-5	0.045	0.15	6.000	0.120
Phenanthrene	85-01-8	0.0011	0.00667	75.000	17.800
Phenol	108-95-2	0.0057	0.05	40.000	NC,a
Pyrene	129-00-0	0.001	0.00667	78.500	95.300
Pyridine	110-86-1	0.006	0.1	-	NC,a
Quinoline	91-22-5	0.051	0.33	-	NC,b
2,4,5-Trichlorophenol	95-95-4	0.0049	0.15	4.000	NC,b
2,4,6-Trichlorophenol	88-06-2	0.0068	0.15	10.000	NCb

mg/kg - miligrams per kilogram

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

- benchmarks are not available for this compound.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 1.9
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Semi-Volatiles in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Acenapthene	83-32-9	0.00092	0.00667	0.02	NC,b
Acenaphthylene	208-96-8	0.0014	0.00667	0.04	NC,b
Acetophenone	98-86-2	0.0055	0.1	-	NC,a
Anthracene	120-12-7	0.0023	0.00667	0.06	NC,b
Atrazine	1912-24-9	0.011	0.2	-	NC,a
Benzaldehyde	100-52-7	0.0069	0.1	-	NC,a
Benzedine	92-87-5	0.0550	0.33	-	NC,a
Benzenethiol	108-98-5	0.0420	0.33	-	NC,a
Benzoic Acid	65-85-0	0.0420	0.66	-	NC,a
Benzo(a)anthracene	56-55-3	0.0014	0.00667	0.108	NC,b
Benzo(a)pyrene	50-32-8	0.0023	0.00667	0.15	NC,b
Benzo(b)fluoranthene	205-99-2	0.0023	0.00667	NA	NC,b
Benzo(k)fluoranthene	207-08-9	0.0023	0.00667	NA	NC,b
Benzo(g,h,i)perylene	191-24-2	0.0018	0.00667	0.013	NC,b
Benzyl Alcohol	100-51-6	0.1400	0.33	-	NC,a
Benzyl butyl phthalate	85-68-7	0.0037	0.05	11	NC,b
1,1'Biphenyl	92-52-4	0.0072	0.05	-	NC,a
bis(2-Chloroethoxy)methane	111-91-1	0.0160	0.1	1.32	NC,a
bis(2-Chloroethyl)ether	111-44-4	0.0041	0.1	2.86	NC,a
bis(2-Ethylhexyl)phthalate	117-81-7	0.0160	0.05	0.75	NC,b
bis-(2-Chloroisopropyl)ether	108-60-1	0.0052	0.1	-	NC,a
4-Bromophenyl phenyl ether	101-55-3	0.0047	0.05	1.3	NC,b
Caprolactam	105-60-2	0.0078	0.33	-	NC,a
Carbazole	86-74-8	0.0093	0.05	3.28	NC,b
4-Chloroaniline	106-47-8	0.0052	0.15	16.4	NC,a
4-Chloro-3-methylphenol	59-50-7	0.0510	0.15	0.0002	NC,a
2-Chloronaphthalene	91-58-7	0.0063	0.05	3.5	NC,b
2-Chlorophenol	95-57-8	0.0036	0.05	0.22	NC,a
4-Chlorophenyl phenyl ether	7005-72-3	0.0036	0.05	1.37	NC,b
Chrysene	218-01-9	0.0010	0.00667	0.166	NC,b

Table 1.9
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Semi-Volatiles in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit (mg/kg)	[1]Reporting Limit (mg/kg)	[2]COPEC Screening Direct (mg/kg)	[2]COPEC Screening Ingestion (mg/kg)
Dibenz(a,h)acridine	226-36-8	0.0640	0.33	-	NC,a
Dibenz(a,h)anthracene	53-70-3	0.0015	0.00667	0.033	NC,b
Dibenzofuran	132-64-9	0.0008	0.05	2	NC,b
3,3'-Dichlorobenzidine	91-94-1	0.0049	0.1	2	NC,b
2,4-Dichlorophenol	120-83-2	0.0053	0.15	0.37	NC,a
Diethylphthalate	84-66-2	0.0062	0.05	0.63	NC,a
2,4-Dimethylphenol	105-67-9	0.0068	0.15	0.05	NC,a
Dimethyl phthalate	99-65-0	0.0064	0.05	523	NC,a
Di-n-butylphthalate	84-74-2	0.0050	0.05	11	NC,b
Di-n-octylphthalate	117-84-0	0.0110	0.05	708	NC,b
4,6-Dinitro-2-Methylphenol	534-52-1	0.0470	0.15	0.01	NC,a
2,4-Dinitrophenol	51-28-5	0.0410	0.33	0.01	NC,a
2,4-Dinitrotoluene	121-14-2	0.0057	0.2	0.65	NC,a
2,6-Dinitrotoluene	606-20-2	0.0058	0.2	0.09	NC,a
1,4 Dioxane	123-91-1	0.0130	0.1	-	-
Fluoranthene	206-44-0	0.0009	0.00667	0.423	NC,b
Fluorene	86-73-7	0.0013	0.00667	0.08	NC,b
Hexachlorobenzene	118-74-1	0.0014	0.00667	0.1	NC,b
Hexachlorobutadiene	87-68-3	0.0025	0.05	0.05	NC,b
Hexachlorocyclopentadiene	77-47-4	0.0029	0.33	0.003	NC,b
Hexachloroethane	67-72-1	0.0049	0.05	0.07	NC,b
Indene	95-13-6	0.0970	0.33	-	NC,a
Indeno(1,2,3-cd)pyrene	193-39-5	0.0020	0.00667	0.017	NC,b
Isophorone	78-59-1	0.0035	0.05	1.15	NC,a
1-Methylnaphthalene	90-12-0	0.0012	0.00667	-	NC,a
2-Methylnaphthalene	91-57-6	0.0010	0.00667	0.07	NC,b
Methylphenol (m-Cresol)	108-39-4	0.0043	0.2	-	NC,a
2-Methylphenol (o-Cresol)	95-48-7	0.0067	0.2	0.005	NC,a
4-Methylphenol (p-Cresol)	106-44-5	0.0058	0.2	4	NC,a
Naphthalene	91-20-3	0.0009	0.00667	0.18	NC,b

Table 1.9
Ecological Benchmarks, Method Detection Limits and Reporting Limits for Semi-Volatiles in Sediment
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Semi-Volatiles (Method SW846 8270)	CAS Number	[1]Method Detection Limit	[1]Reporting Limit	[2]COPEC Screening Direct	[2]COPEC Screening Ingestion
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
2-Nitroaniline	88-74-4	0.0051	0.2	48.3	NC,a
3-Nitroaniline	99-09-2	0.0032	0.2	59.5	NC,a
4-Nitroaniline	100-01-6	0.0036	0.2	36.2	NC,a
Nitrobenzene	98-95-3	0.0064	0.1	0.59	NC,a
2-Nitrophenol	88-75-5	0.0034	0.05	3.18	NC,a
4-Nitrophenol	100-02-7	0.0810	0.33	0.04	NC,a
N-Nitro-di-n-propylamine	621-64-7	0.0076	0.05	NA	NC,a
N-Nitrosodimethylamine	62-75-9	0.0054	0.1	.	NC,a
N-Nitrosodiphenylamine	86-30-6	0.0041	0.05	0.7	NC,a
2, 2'-Oxybis(1-chloropropane)	108-60-1	0.0052	0.1	NA	NC,a
Pentachlorophenol	87-86-5	0.0450	0.15	0.07	NC,b
Phenanthrene	85-01-8	0.0011	0.00667	0.2	NC,b
Phenol	108-95-2	0.0057	0.05	0.05	NC,a
Pyrene	129-00-0	0.0010	0.00667	0.195	NC,b
Pyridine	110-86-1	0.0060	0.1	-	NC,a
Quinoline	91-22-5	0.0510	0.33	-	NC,a
2,4,5-Trichlorophenol	95-95-4	0.0049	0.15	1.45	NC,b
2,4,6-Trichlorophenol	88-06-2	0.0068	0.15	0.02	NC,b

mg/kg - milligrams per kilogram

NC,a - Ingestion screening value not calculated. Not considered an ingestion COPEC unless direct exposure ESV is exceeded.

NC,b - Ingestion screening value not calculated, however, automatically considered a COPEC if detected based upon bioaccumulation potential.

- benchmarks are not available for this compound.

[1] Method Detection Limit and Reporting Limit based on Severn Trent results.

[2] Benchmark values derived from URS DRAFT Problem Formulation Document (August, 2005).

Table 11-1
Preventative Maintenance Schedule for the Gas Chromatograph
Crab Orchard National Wild Life Refuge NPL Site – AUS OU

Daily	As Needed	Quarterly/Semi-annually/Annually
Check for sufficient supply of carrier and detector gases. Check for correct column flow and/or inlet pressures.	Replace front portion of column packing or break off front portion of capillary columns. Replace column if this fails to restore column performance or when column performance (e.g. peak tailing, poor resolution, high backgrounds, etc.) indicates it is required.	Quarterly ELCD: change-roughing resin, clean cell assembly. Quarterly FID: clean detector
Check temperatures of injectors and detectors. Verify temperature programs.	Change glass wool plug in injection port and/or replace injection port liner when front portion of column packing is changed or front portion of capillary column is removed.	Semi-annually ECD: perform wipe test.
Check inlets, septa. Replace septum Clean injector port	-	Annually ELCD: change finishing resin, clean solvent filter. Annually FID: Replace flame tip ECD: detector cleaning and re-foiling, every five years or whenever loss of sensitivity, or erratic response or failing resolution is observed.
Check baseline level.	Perform gas purity check (if high baseline indicates that impure carrier gas may be in use).	
Check reactor temperature of electrolytic conductivity detector. Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks. Clip column leader	Replace or repair flow controller if constant gas flow cannot be maintained.	
	Replace fuse.	
	Reactivate external carrier gas dryers.	
	Detectors: clean when baseline indicates contamination or when response is low. FID: clean/replace jet, replace igniter. NPD: clean/replace collector assembly. PID: clean lamp window monthly or replace as needed, replace seals. ELCD: check solvent flow weekly, change reaction tube, replace solvent, change reaction gas, clean/replace Teflon® transfer line. ECD: follow manufacturers suggested maintenance schedule	
	Reactivate flow controller filter dryers when presence of moisture is suspected.	

Table 11-10
Preventative Maintenance Schedule for Inductively Coupled Plasma/Mass Spectrometry Unit
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Inductively Coupled Plasma/Mass Spectrometry (ICP/MS):

Daily	Weekly	Monthly	Quarterly	Annually	As Needed
Check sample waste container level.	Check peristaltic pump: proper roller pressure, sample introduction tubing, correct pump rotation, condition of drain tubing.	Clean all filters and fans.	Replace oil in roughing pumps.	Replace oil in turbo-molecular pump.	Check electronic settings for optimum sensitivity: resolution, mass calibration, ion optics, CEM, deflector voltage.
Check quartz torch condition.	Check condition of sampler and skimmer cones.	Check recirculator water level.			
Measure quartz torch for proper alignment.	Check and drain oil mist eliminator on roughing pumps.				
Clean spray chamber and nebulizer.					
Check oil level of roughing pumps.					

Table 11-2
Preventative Maintenance Schedule for the Ion Chromatograph
Crab Orchard National Wildlife Refuge NPL Site – AUS OU

As Needed	Daily	Weekly	Monthly	Semi-annually
Clean micromembrane suppressor when decreases in sensitivity are observed.	Check plumbing/leaks.	Check pump heads for leaks.	Check all air and liquid lines for discoloration and crimping, if indicated.	Lubricate left hand piston.
Check fuses when power problems occur.	Check gases.	Check filter (inlet)	Check/change bed supports guard and analytical columns, if indicated.	Clean conductivity cell.
Reactivate or change column when peak shape and resolution deteriorate or when retention time shortening indicates that exchange sites have become deactivated.	Check pump pressure.			Check conductivity cell for calibration.
De-gas pump head when flow is erratic.	Check conductivity meter.			

Table 11-3
Preventative Maintenance Schedule for the Mass Spectrometer
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Mass Spectrometer :

Daily	Weekly	As Needed	Quarterly	Semi-Annually	Annually
Check for sufficient gas supply. Check for correct column flow and/or inlet pressure.	Check mass calibration (PFTBA or FC-43)	Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed between service contract maintenance.	Check ion source and analyzer (clean, replace parts as needed)	Clean rods	Replace the exhaust filters on the mechanical rough pump every 1-2 years.
Check temperatures of injector, detector. Verify temperature programs.		Replace electron multiplier when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.	Check vacuum, relays, gas pressures and flows		
Check baseline level.		Clean Source, including all ceramics and lenses - the source cleaning is indicated by a variety of symptoms including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination.	Change oil in the mechanical rough pump. Relubricate the turbomolecular pump-bearing wick.		
Check values of lens voltages, electron multiplier, and relative abundance and mass assignments of the calibration compounds.		Repair/replace jet separator.			
		Replace filaments when both filaments burn out or performance indicates need for replacement.			

Table 11-4
Preventative Maintenance Schedule for the pH Meter
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

pH Meter:

Daily	**As Needed**
Inspect electrode.	Clean electrode.
Verify electrodes are properly connected and filled	Refill reference electrode.
Inspect electrode proper levels of filling solutions	
Make sure electrode is stored in buffer	

Table 11-5
Preventative Maintenance Schedule for the Total Organic Carbon Analyzer
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Total Organic Carbon Analyzer :

Daily	As Needed	Weekly	Monthly	Semi-annually
Check: Oxygen supply	Check injection port septum after 50-200 runs.	Check liquid-flow-rate-pump-tubing conditions on autosampler	Clean digestion vessel	Change pump tubing
Persulfate supply	Tube end-fitting connections after 100 hours or use.	Check injection port septum	Clean condenser column Do the leak test	
Acid supply	Indicating drying tube.			
Carrier gas flow rate (~ 150 cc/min)	NDIR zero, after 100 hours of use. Sample pump, after 2000 hours for use.			
IR millivolts for stability (after 30 min. warm-up)	Digestion vessel/condensation chamber, after 2000 hours of use. Permeation tube, after 2000 hours of use. NDIR cell, after 2000 hours of use.			
Reagent reservoirs				

Table 11-6
Preventative Maintenance Schedule for the TRAACS 800 Auto Analyzer, Sonicator, and Ovens
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

TRAACS 800 Auto Analyzer:

As Needed	Daily	Monthly	Semi-Annually	Annually
Replaces air filter when progressive loss of air pressure is observed.	Check air pressure gauge (22 ± 2 psi)	Change all pump tubes (or after 200 hours of pumping	(or after 1000 hours of pumping time)	Lightly lubricate the Linear Sample Rails (use semi-fluid
Replace air valve tubing when occlusion in tubing is observed	Use recommended washout procedure (at end of analysis operations)	Clean sample probe shaft	Replace pump platens	Replace colorimeter lamp (or after 2500 hours of use)

Sonicator:

Daily	As Needed
Daily when used:	Replace probe tip.
Inspect probe tips for inconsistencies (etching/pitting).	
	Disassemble and clean sonicator probe tips.
	Tune sonicator assembly.

Ovens:

Daily	As Needed
Temperatures checked and l	Electronics serviced.

Table 11-7
Preventative Maintenance Schedule for the Cold Vapor Atomic Absorption Unit
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Cold Vapor Atomic Absorption:

Daily	As Needed	Monthly
Clean aspirator by flushing with DI water.	Change source lamp	Clean cell in aqua regia.
Check tubing and replace if needed.		Clean aspirator in aqua regia.
Change silica gel in drying tube.		Clean windows with methanol.
Check argon gas supply.		
Adjust lamp.		

Table 11-8
Preventative Maintenance Schedule for the High Pressure Liquid Chromatograph
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

High Pressure Liquid Chromatograph :

Daily	As Needed
Check level of solution in reservoirs. If adding, verify that solvent is from the same source. If changing, rinse the gas and delivery lines to prevent contamination of the new solvent.	Replace columns when peak shape and resolution indicate that chromatographic performance of the column is below the method requirements.
Check gas supply.	Oil autosampler slides when sample does not advance.
Flush with an appropriate solvent to remove all bubbles.	Rinse flow cell with 1N nitric acid if sensitivity low.
Pre-filter all samples.	Change pump seals when flow becomes inconsistent.
	Repack front end of column
	Backflush column.

Table 11-9
Preventative Maintenance Schedule for the Inductively Coupled Plasma Unit
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Inductively Coupled Plasma (ICP):

Daily	**As Needed**	**Semi-Annually**	**Annually**
Check gases	Clean plasma torch assembly to remove accumulated deposits.	Change vacuum pump oil.	Notify manufacturer service engineer for scheduled preventive maintenance service.
Check that argon tank pressure is 50-60 psi and that a spare tank is available.			
Check aspiration tubing			
Check vacuum pump gage. (<10 millitorr)	Clean nebulizer and drain chamber; keep free flowing to maintain optimum performance.	Replace coolant water filter. (may require more or less frequently depending on the	
Check that cooling water supply system is full and drain bottle is not full. Also that drain tubing is clear, tight fitting and has few bends.	Clean filters on back of power unit to remove dust.		
Check that nebulizer is not clogged.	Replace when needed: peristaltic pump tubing sample capillary tubing autosampler sipper probe		
Check that capillary tubing is clean and in good condition.	Check yttrium position.		
Check that peristaltic pump windings are secure.	Check O-rings		
Check that high voltage switch is on.	Clean/lubricate pump rollers.		
Check that exhaust screens are clean.			
Check that torch, glassware, aerosol injector tube, bonnet are clean.			

Table 12-1
Percent Recoveries and RPD's for Volatiles in a Solid Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters	CAS Number	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Volatiles			LCL	UCL		LCL	UCL	
Acetone	67-64-1	8260B	58	130	30	10	130	66
Benzene	71-43-2	8260B	75	129	20	55	129	20
Bromobenzene	108-86-1	8260B	0	0	0	0	0	0
Bromodichloromethane	75-27-4	8260B	72	125	30	47	125	51
Bromoform	75-25-2	8260B	43	149	30	26	149	64
n-Butylbenzene	104-51-8	8260B	0	0	0	0	0	0
sec-Butlybenzene	135-98-8	8260B	0	0	0	0	0	0
tert-Butylbenzene	98-06-6	8260B	0	0	0	0	0	0
Bromomethane	74-83-9	8260B	24	152	30	15	152	72
2-Butanone	78-93-3	8260B	27	200	46	21	200	60
Carbon disulfide	75-15-0	8260B	50	137	30	27	137	73
Carbon tetrachloride	56-23-5	8260B	57	137	30	32	137	68
Chlorobenzene	108-90-7	8260B	75	127	22	49	127	22
Dibromochloromethane	124-48-1	8260B	49	135	30	44	135	61
Chloroethane	75-00-3	8260B	31	144	30	32	144	66
Chloroform	67-66-3	8260B	73	115	30	59	115	46
Chloromethane	74-87-3	8260B	15	136	30	28	136	81
Cyclohexane	110-82-7	8260B	50	150	20	50	150	20
1,2-Dibromo-3-chloropropane	96-12-8	8260B	50	150	20	50	150	20
1,2-Dibromoethane	106-93-4	8260B	50	150	20	50	150	20
1,2-Dichlorobenzene	95-50-1	8260B	50	150	20	50	150	20
1,3-Dichlorobenzene	541-73-1	8260B	50	150	20	50	150	20
1,4-Dichlorobenzene	106-46-7	8260B	50	150	20	50	150	20
Dichlorodifluoromethane	75-71-8	8260B	50	150	20	50	150	20
1,1-Dichloroethane	75-34-3	8260B	77	119	30	56	119	54
1,2-Dichloroethane	107-06-2	8260B	78	121	30	56	121	38
cis-1,2-Dichloroethene	156-59-4	8260B	77	114	30	48	114	52
trans-1,2-Dichloroethene	156-60-5	8260B	68	117	30	47	117	58
1,1-Dichloroethene	75-35-4	8260B	55	142	27	43	142	27
1,2-Dichloropropane	78-87-5	8260B	78	116	30	54	116	43
cis-1,3-Dichloropropene	10061-01-5	8260B	71	125	30	30	125	49
trans-1,3-Dichloropropene	10061-02-6	8260B	67	125	30	67	125	125
1,3 - Dichloropropene	542-75-6	8260B	*	*	*	*	*	*
Ethylbenzene	100-41-4	8260B	79	114	30	79	114	114
2-Hexanone	591-78-6	8260B	29	200	41	29	200	200
Isopropylbenzene	98-82-8	8260B	50	150	20	50	150	20

Table 12-1
Percent Recoveries and RPD's for Volatiles in a Solid Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters	CAS Number	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Volatiles			LCL	UCL		LCL	UCL	
p-Isopropyltoluene	99-87-6	260B	0	0	0	0	0	0
Methyl acetate	79-20-9	8260B	50	150	20	50	150	20
Methylcyclohexane	108-87-2	8260B	50	150	20	50	150	20
Methylene chloride	75-09-2	8260B	58	130	30	58	130	130
4-Methyl-2-pentanone	108-10-1	8260B	68	142	60	68	142	142
Methyl tert-butyl ether	1634-04-4	8260B	50	150	20	50	150	20
n-Propylbenzene	103-65-1	8260B	0	0	0	0	0	0
Styrene	100-42-5	8260B	80	114	30	80	114	114
1,1,1,2-Tetrachloroethane	630-2-06	8260B	0	0	0	0	0	0
1,1,2,2-Tetrachloroethane	79-34-5	8260B	70	133	30	70	133	133
Tetrachloroethene	127-18-4	8260B	72	120	30	72	120	120
Toluene	108-88-3	8260B	71	130	24	71	130	130
1,2,3-Trichlorobenzene	87-61-6	8260B	0	0	0	0	0	0
1,2,4-Trichlorobenzene	120-82-1	8260B	50	150	20	50	150	20
1,1,1-Trichloroethane	71-55-6	8260B	67	123	30	67	123	123
1,1,2-Trichloroethane	79-00-5	8260B	82	116	30	82	116	116
Trichloroethene	79-01-6	8260B	70	131	23	70	131	131
Trichlorofluoromethane	75-69-4	8260B	50	150	20	50	150	20
1,2,3-Trichloropropane	96-18-4	8260B	0	0	0	0	0	0
1,2,4-Trimethylbenzene	95-63-6	8260B	0	0	0	0	0	0
1,3,5-Trimethylbenzene	108-67-8	8260B	0	0	0	0	0	0
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	8260B	50	150	20	50	150	20
Vinyl chloride	75-01-4	8260B	24	152	30	24	152	152
Xylenes (total)	95-47-6	8260B	80	114	30	80	114	114

LCL = Lower Control Limit
UCL = Upper Control Limit
LCS = Laboratory Control Sample
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference
*= Severn Trent Laboratories provides information on 1,3-Dichloropropane as *cis* and *trans* not Total.

Table 12-10
Percent Recoveries and RPD's for Miscellaneous Inorganic Analyses in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
General Chemistry		**LCL**	**UCL**		**LCL**	**UCL**	
Total Alkalinity	310.1	80	120	20	80	120	20
pH (solid)	9045C	97	103	20	97	103	20
Total Organic Carbon	Walkley-Black	51	128	20	51	128	20

Aqueous Matrix:

Parameters	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
General Chemistry		**LCL**	**UCL**		**LCL**	**UCL**	
Nitrogen, as Ammonia	350.1	85	114	20	63	126	29
Nitrate/Nitrite as N	353.2	90	110	20	85	115	20
Total Phosphorus/Orthophosphate	365.2	89	115	20	10	199	46
Total Sulfide	376.1	79	104	20	56	139	20
Sulfate	300	80	112	20	75	107	20
Total Alkalinity	160.2	90	127	20	22	151	31
Total Suspended Solids	160.2	69	120	20	10	160	24
Total Dissolved Solids	160.2	66	119	20	66	119	20

LCL = Lower Control Limit
UCL = Upper Control Limit
LCS = Laboratory Control Sample
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference

Table 12-2
Percent Recoveries and RPD's for Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Volatiles	**Cas Number**		**LCL**	**UCL**		**LCL**	**UCL**	
Acetone	67-64-1	8260B	22	200	95	22	200	95
Benzene	71-43-2	8260B	80	116	20	80	116	20
Bromobenzene	108-86-1	8260B	0	0	0	0	0	0
Bromodichloromethane	75-27-4	8260B	87	130	30	87	130	30
Bromoform	75-25-2	8260B	76	150	30	76	150	30
Bromomethane	74-83-9	8260B	64	129	30	64	129	30
n-Butylbenzene	104-51-8	8260B	0	0	0	0	0	0
sec-Butylbenzene	135-98-8	8260B	0	0	0	0	0	0
tert-Butylbenzene	98-06-6	8260B	0	0	0	0	0	0
2-Butanone	78-93-3	8260B	28	237	65	28	237	65
Carbon disulfide	75-15-0	8260B	73	139	30	73	139	30
Carbon tetrachloride	56-23-5	8260B	75	149	30	75	149	30
Chlorobenzene	108-90-7	8260B	76	117	20	76	117	20
Dibromochloromethane	124-48-1	8260B	81	138	30	81	138	30
Chloroethane	75-00-3	8260B	66	126	30	66	126	30
Chloroform	67-66-3	8260B	84	128	30	84	128	30
Chloromethane	74-87-3	8260B	48	123	30	48	123	30
Cyclohexane	110-82-7	8260B	50	150	20	50	150	20
1,2-Dibromo-3-chloropropane	96-12-8	8260B	50	150	20	50	150	20
1,2-Dibromoethane	106-93-4	8260B	50	150	20	50	150	20
1,2-Dichlorobenzene	95-50-1	8260B	50	150	20	50	150	20
1,3-Dichlorobenzene	541-73-1	8260B	50	150	20	50	150	20
1,4-Dichlorobenzene	106-46-7	8260B	50	150	20	50	150	20
Dichlorodifluoromethane	75-71-8	8260B	50	150	20	50	150	20
1,1-Dichloroethane	75-34-3	8260B	86	123	30	86	123	30
1,2-Dichloroethane	107-06-2	8260B	79	136	30	79	136	30
cis-1,2-Dichloroethene	156-59-4	8260B	85	113	30	85	113	30
trans-1,2-Dichloroethene	156-60-5	8260B	79	120	30	79	120	30
1,1-Dichloroethene	75-35-4	8260B	63	130	20	63	130	20
1,2-Dichloropropane	78-87-5	8260B	82	115	30	82	115	30
1,3-Dichloropropene	542-75-6	8260B	*	*	*	*	*	*
cis-1,3-Dichloropropene	10061-01-5	8260B	84	130	30	84	130	30
trans-1,3-Dichloropropene	10061-02-6	8260B	84	130	30	84	130	30

Table 12-2
Percent Recoveries and RPD's for Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Volatiles	**Cas Number**		**LCL**	**UCL**		**LCL**	**UCL**	
Ethylbenzene	100-41-4	8260B	86	116	30	86	116	30

Table 12-2
Percent Recoveries and RPD's for Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Volatiles	**Cas Number**		**LCL**	**UCL**		**LCL**	**UCL**	
2-Hexanone	591-78-6	8260B	35	200	52	35	200	52
Isopropylbenzene	98-82-8	8260B	50	150	20	50	150	20
p-Isopropyltoulene	99-87-6	8260B	0	0	0	0	0	0
Methyl acetate	79-20-9	8260B	50	150	20	50	150	20
Methylcyclohexane	108-87-2	8260B	50	150	20	50	150	20
Methylene chloride	75-09-2	8260B	78	118	30	78	118	30
4-Methyl-2-pentanone	108-10-1	8260B	78	141	32	78	141	32
Methyl tert-butyl ether	1634-04-4	8260B	50	150	20	50	150	20
n-Propylbenzene	103-65-1	8260B	50	150	20	50	150	20
Styrene	100-42-5	8260B	85	117	30	85	117	30
1,1,1,2-Tetrachloroethane	630-2-06	8260B	50	150	20	50	150	20
1,1,2,2-Tetrachloroethane	79-34-5	8260B	85	118	30	85	118	30
Tetrachloroethene	127-18-4	8260B	88	113	30	88	113	30
Toluene	108-88-3	8260B	74	119	20	74	119	20
1,2,3-Trichlorobenzene	87-61-6	8260B	0	0	0	0	0	0
1,2,4-Trichlorobenzene	120-82-1	8260B	0	0	0	0	0	0
1,1,1-Trichloroethane	71-55-6	8260B	78	140	30	78	140	30
1,1,2-Trichloroethane	79-00-5	8260B	83	122	30	83	122	30
Trichloroethene	79-01-6	8260B	75	122	20	75	122	20
Trichlorofluoromethane	75-69-4	8260B	0	0	0	0	0	0
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	8260B	0	0	0	0	0	0
1,2,3-Trichloropropane	96-18-4	8260B	0	0	0	0	0	0
1,2,4-Trimethylbenzene	95-63-6	8260B	0	0	0	0	0	0
1,3,5-Trimethylbenzene	108-67-8	8260B	0	0	0	0	0	0
Vinyl chloride	75-01-4	8260B	61	120	30	61	120	30
Xylenes (total)	95-47-6	8260B	87	116	30	87	116	30

LCL = Lower Control Limit

UCL = Upper Control Limit

LCS = Laboratory Control Sample

MS/MSD = Matrix Spike/Matrix Spike Duplicate

RPD = Relative Percent Difference

*= Severn Trent Laboratories provides information on 1,3-Dichloropropane as *cis* and *trans* not Total.

Table 12-3
Percent Recovery and RPD for Semi-Volatiles in a Solid Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Semi-Volatiles	**CAS Number**		**LCL**	**UCL**		**LCL**	**UCL**	
Acenaphthene	83-32-9	8270C	44	108	44	13	133	44
Acenaphthylene	208-96-8	8270C	55	110	30	43	120	75
Acetophenone	98-86-2	8270C	0	0	0	0	0	0
Anthracene	120-12-7	8270C	57	116	30	34	137	83
Atrazine	1912-24-9	8270C	50	150	20	50	150	20
Benzaldehyde	100-52-7	8270C	50	150	20	50	150	20
Benzenethiol	108-98-5	8270C	0	0	0	0	0	0
Benzedine	92-87-5	8270C	0	0	0	0	0	0
Benzoic Acid	65-85-0	8270C	22	154	65	10	143	99
Benzo(a)anthracene	56-55-3	8270C	56	110	30	30	136	63
Benzo(b)fluoranthene	205-99-2	8270C	54	116	30	31	139	67
Benzo(k)fluoranthene	207-08-9	8270C	54	110	36	30	133	84
Benzo(ghi)perylene	191-24-2	8270C	48	124	31	23	142	89
Benzo(a)pyrene	50-32-8	8270C	56	115	30	28	142	86
Benzyl Alcohol	100-51-6	8270C	50	150	20	50	150	20
1,1'-Biphenyl	92-52-4	8270C	50	150	20	50	150	20
bis(2-Chloroethoxy)methane	111-91-1	8270C	59	110	30	46	116	97
bis(2-Chloroethyl) ether	111-44-4	8270C	62	111	30	49	123	93
bis(2-Ethylhexyl) phthalate	117-81-7	8270C	53	115	30	36	131	54
bis(2-chloroisopropyl-ether)	108-60-1	8270C	53	115	30	41	125	89
4-Bromophenyl phenyl ether	101-55-3	8270C	58	110	30	47	121	95
Butyl benzyl phthalate	85-68-7	8270C	54	113	30	34	136	94
Caprolactam	105-60-2	8270C	50	150	20	50	150	20
Carbazole	86-74-8	8270C	56	117	31	40	130	85
4-Chloroaniline	106-47-8	8270C	28	110	33	10	110	99
4-Chloro-3-methylphenol	59-50-7	8270C	43	110	55	17	128	55
2-Chloronaphthalene	91-58-7	8270C	52	116	30	43	125	75
2-Chlorophenol	95-57-8	8270C	43	110	54	17	116	54
4-Chlorophenyl phenyl ether	7005-72-3	8270C	59	110	30	47	119	74
Chrysene	218-01-9	8270C	56	110	30	28	139	63
Dibenz(a,h)anthracene	53-70-3	8270C	50	129	33	31	142	99
Dibenz(a,h)acridine	226-36-8	8270C	0	0	0	0	0	0
Dibenzofuran	132-64-9	8270C	57	110	30	35	132	58
Di-n-butyl phthalate	84-74-2	8270C	58	114	30	44	128	74

Table 12-3
Percent Recovery and RPD for Semi-Volatiles in a Solid Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Semi-Volatiles	**CAS Number**		**LCL**	**UCL**		**LCL**	**UCL**	
3,3'-Dichlorobenzidine	91-94-1	8270C	22	110	33	10	110	99

Table 12-3
Percent Recovery and RPD for Semi-Volatiles in a Solid Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Semi-Volatiles	**CAS Number**		**LCL**	**UCL**		**LCL**	**UCL**	
2,4-Dichlorophenol	120-83-2	8270C	60	111	30	45	122	85
Diethyl phthalate	84-66-2	8270C	57	112	30	45	122	76
2,4-Dimethylphenol	105-67-9	8270C	41	110	35	31	119	99
Dimethyl phthalate	99-65-0	8270C	60	111	30	48	124	75
4,6-Dinitro-2-methylphenol	534-52-1	8270C	37	126	37	10	142	99
2,4-Dinitrophenol	51-28-5	8270C	15	131	53	10	149	99
2,4-Dinitrotoluene	121-14-2	8270C	48	111	45	10	171	45
2,6-Dinitrotoluene	606-20-2	8270C	61	121	30	45	124	99
Di-n-octyl phthalate	117-84-0	8270C	47	129	33	34	143	99
1,4 Dioxane	123-91-1	8270C	10	200	30	10	200	30
Fluoranthene	206-44-0	8270C	57	118	30	25	150	92
Fluorene	86-73-7	8270C	57	110	30	35	133	80
Hexachlorobenzene	118-74-1	8270C	57	111	30	45	123	74
Hexachlorobutadiene	87-68-3	8270C	56	113	30	43	126	86
Hexachlorocyclopentadiene	77-47-4	8270C	10	113	57	10	110	99
Hexachloroethane	67-72-1	8270C	61	110	30	36	134	97
Indene	95-13-6	8270C	0	0	0	0	0	0
Indeno(1,2,3-cd)pyrene	193-39-5	8270C	44	128	54	20	147	73
Isophorone	78-59-1	8270C	58	110	30	45	116	95
1-Methylnaphthalene	90-12-0	8270C	50	150	20	50	150	20
2-Methylnaphthalene	91-57-6	8270C	58	110	30	30	137	79
Methylphenol (m-Cresol)	108-39-4	8270C	0	0	0	0	0	0
2-Methylphenol	95-48-7	8270C	41	102	39	33	113	39
4-Methylphenol	106-44-5	8270C	56	110	30	36	123	86
Naphthalene	91-20-3	8270C	59	110	30	31	138	65
2-Nitroaniline	88-74-4	8270C	58	113	30	42	126	99
3-Nitroaniline	99-09-2	8270C	42	110	37	17	113	99
4-Nitroaniline	100-01-6	8270C	42	116	40	14	125	99
Nitrobenzene	98-95-3	8270C	62	110	30	49	120	99
2-Nitrophenol	88-75-5	8270C	55	118	30	44	125	99
4-Nitrophenol	100-02-7	8270C	22	128	64	10	148	64
N-Nitrosodiphenylamine	86-30-6	8270C	58	113	30	37	135	94
N-Nitrosodi-n-propylamine	621-64-7	8270C	38	110	50	12	128	50
N-Nitrosodimethylamine	62-75-9	8270C	50	150	20	50	150	20

Table 12-3
Percent Recovery and RPD for Semi-Volatiles in a Solid Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Semi-Volatiles	**CAS Number**		**LCL**	**UCL**		**LCL**	**UCL**	
2,2'-oxybis(1-Chloropropane)	108-60-1	8270C	50	150	20	50	150	20
Pentachlorophenol	87-86-5	8270C	10	123	87	10	144	87
Phenanthrene	85-01-8	8270C	56	110	30	24	145	81
Phenol	108-95-2	8270C	35	110	50	10	148	50
Pyrene	129-00-0	8270C	42	122	66	10	218	66
Pyridine	110-86-1	8270C	70	130	30	70	130	30
Quinoline	91-22-5	8270C	50	150	20	50	150	20
2,4,5-Trichlorophenol	95-95-4	8270C	52	115	37	39	123	99
2,4,6-Trichlorophenol	88-06-2	8270C	51	112	30	43	123	99

LCL = Lower Control Limit
UCL = Upper Control Limit
LCS = Laboratory Control Sample
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference

Table 12-4
Percent Recoveries and RPD's for Semi-Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Semi-Volatiles	**CAS Number**		**LCL**	**UCL**		**LCL**	**UCL**	
Acenaphthene	83-32-9	8270C	39	118	35	26	118	35
Acenaphthylene	208-96-8	8270C	51	110	30	49	111	51
Acetophenone	98-86-2	8270C	0	0	0	0	0	0
Anthracene	120-12-7	8270C	54	116	33	49	118	51
Atrazine	1912-24-9	8270C	50	150	20	50	150	20
Benzaldehyde	100-52-7	8270C	50	150	20	50	150	20
Benzenethiol	108-98-5	8270C	0	0	0	0	0	0
Benzedine	92-87-5	8270C	0	0	0	0	0	0
Benzoic Acid	65-85-0	8270C	10	151	99	10	184	99
Benzo(a)anthracene	56-55-3	8270C	49	112	34	48	115	51
Benzo(b)fluoranthene	205-99-2	8270C	51	115	38	44	123	54
Benzo(k)fluoranthene	207-08-9	8270C	52	116	34	46	123	53
Benzo(ghi)perylene	191-24-2	8270C	47	118	35	44	122	55
Benzo(a)pyrene	50-32-8	8270C	50	116	34	44	122	51
Benzyl Alcohol	100-51-6	8270C	50	150	20	50	150	20
1,1'-Biphenyl	92-52-4	8270C	50	150	20	50	150	20
bis(2-Chloroethoxy)methane	111-91-1	8270C	54	112	32	57	114	49
bis(2-Chloroethyl) ether	111-44-4	8270C	59	114	30	57	120	51
bis(2-Ethylhexyl) phthalate	117-81-7	8270C	49	124	39	43	128	84
bis(2-chloroisopropyl-ether)	108-60-1	8270C	53	118	31	53	122	52
4-Bromophenyl phenyl ether	101-55-3	8270C	56	113	33	51	119	51
Butyl benzyl phthalate	85-68-7	8270C	46	121	40	41	127	84
Caprolactam	105-60-2	8270C	50	150	20	50	150	20
Carbazole	86-74-8	8270C	50	118	34	48	119	53
4-Chloroaniline	106-47-8	8270C	21	110	41	10	110	99
4-Chloro-3-methylphenol	59-50-7	8270C	29	124	55	21	124	55
2-Chloronaphthalene	91-58-7	8270C	50	116	30	51	119	51
2-Chlorophenol	95-57-8	8270C	19	124	43	19	124	43
4-Chlorophenyl phenyl ether	7005-72-3	8270C	56	112	31	51	118	51
Chrysene	218-01-9	8270C	49	118	34	49	118	52
Dibenz(a,h)anthracene	53-70-3	8270C	48	124	36	45	127	57
Dibenz(a,h)acridine	226-36-8	8270C	0	0	0	0	0	0
Dibenzofuran	132-64-9	8270C	53	112	30	51	117	51
Di-n-butyl phthalate	84-74-2	8270C	50	116	36	41	121	53
3,3'-Dichlorobenzidine	91-94-1	8270C	10	110	75	10	110	99

Table 12-4
Percent Recoveries and RPD's for Semi-Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Semi-Volatiles	**CAS Number**		**LCL**	**UCL**		**LCL**	**UCL**	
2,4-Dichlorophenol	120-83-2	8270C	51	118	43	52	121	88
Diethyl phthalate	84-66-2	8270C	14	135	47	10	148	81
2,4-Dimethylphenol	105-67-9	8270C	10	123	44	10	125	62
Dimethyl phthalate	99-65-0	8270C	10	150	51	10	159	99
4,6-Dinitro-2-methylphenol	534-52-1	8270C	22	143	79	20	158	99
2,4-Dinitrophenol	51-28-5	8270C	10	146	99	10	168	99
2,4-Dinitrotoluene	121-14-2	8270C	47	131	32	31	131	32
2,6-Dinitrotoluene	606-20-2	8270C	59	125	32	58	127	82
Di-n-octyl phthalate	117-84-0	8270C	49	130	42	39	144	89
1,4 Dioxane	123-91-1	8270C	10	200	30	10	200	30
Fluoranthene	206-44-0	8270C	54	118	33	49	122	53
Fluorene	86-73-7	8270C	53	114	31	51	119	51
Hexachlorobenzene	118-74-1	8270C	54	114	34	48	123	51
Hexachlorobutadiene	87-68-3	8270C	36	113	47	35	118	56
Hexachlorocyclopentadiene	77-47-4	8270C	10	114	51	10	113	97
Hexachloroethane	67-72-1	8270C	29	115	49	31	118	92
Indene	95-13-6	8270C	0	0	0	0	0	0
Indeno(1,2,3-cd)pyrene	193-39-5	8270C	45	120	43	39	126	59
Isophorone	78-59-1	8270C	54	111	33	56	112	50
1-Methylnaphthalene	90-12-0	8270C	50	150	20	50	150	20
2-Methylnaphthalene	91-57-6	8270C	52	110	32	45	119	51
Methylphenol (m-Cresol)	108-39-4	8270C	0	0	0	0	0	0
2-Methylphenol	95-48-7	8270C	33	115	31	29	115	31
4-Methylphenol	106-44-5	8270C	49	110	35	29	122	55
Naphthalene	91-20-3	8270C	49	112	35	50	176	52
2-Nitroaniline	88-74-4	8270C	53	122	34	48	125	83
3-Nitroaniline	99-09-2	8270C	10	140	39	10	140	99
4-Nitroaniline	100-01-6	8270C	32	116	49	20	122	99
Nitrobenzene	98-95-3	8270C	56	119	32	56	125	81
2-Nitrophenol	88-75-5	8270C	46	129	49	51	131	77
4-Nitrophenol	100-02-7	8270C	19	144	34	10	145	34
N-Nitrosodiphenylamine	86-30-6	8270C	49	117	36	49	117	51
N-Nitrosodi-n-propylamine	621-64-7	8270C	30	115	36	18	115	36
N-Nitrosodimethylamine	62-75-9	8270C	49	117	36	0	0	0
2,2'-oxybis(1-Chloropropane)	108-60-1	8270C	50	150	20	50	150	20

Table 12-4
Percent Recoveries and RPD's for Semi-Volatiles in an Aqueous Matrix
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Semi-Volatiles	**CAS Number**		**LCL**	**UCL**		**LCL**	**UCL**	
Pentachlorophenol	87-86-5	8270C	10	140	56	10	140	56
Phenanthrene	85-01-8	8270C	53	112	32	52	117	51
Phenol	108-95-2	8270C	10	131	43	10	131	43
Pyrene	129-00-0	8270C	46	130	31	27	138	31
Pyridine	110-86-1	8270C	10	110	30	10	110	99
Quinoline	91-22-5	8270C	50	150	20	50	150	20
2,4,5-Trichlorophenol	95-95-4	8270C	46	122	48	45	125	74
2,4,6-Trichlorophenol	88-06-2	8270C	46	118	48	46	122	98

LCL = Lower Control Limit
UCL = Upper Control Limit
LCS = Laboratory Control Sample
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference

Table 12-5
Percent Recoveries and RPD's for Metals in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	CAS Number	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Metals			LCL	UCL		LCL	UCL	
Aluminum	7429-90-5	6010B	80	120	20	75	125	20
Antimony	7440-36-0	6010B	80	120	20	75	125	20
Arsenic	7440-38-2	6010B	80	120	20	75	125	20
Barium	7440-39-3	6010B	80	120	20	75	125	20
Beryllium	7440-41-7	6010B	80	120	20	75	125	20
Boron	7440-42-8	6010B	80	120	20	75	125	20
Cadmium	7440-43-9	6010B	80	120	20	75	125	20
Calcium	7440-70-2	6010B	80	120	20	75	125	20
Chromium	7440-47-3	6010B	80	120	20	75	125	20
Chromium VI	18540-29-9	7196A	10	200	100	10	200	100
Cobalt	7440-48-4	6010B	80	120	20	75	125	20
Copper	7440-50-8	6010B	80	120	20	75	125	20
Cyanide	57-12-5	9012A	68	123	20	50	134	20
Iron	7439-89-6	6010B	73	137	20	75	125	20
Lead	7439-92-1	6010B	80	120	20	75	125	20
Magnesium	7439-95-4	6010B	80	120	20	75	125	20
Manganese	7439-96-5	6010B	80	120	20	75	125	20
Mercury	7439-97-6	7470/7471	52	127	20	10	209	20
Nickel	7440-02-0	6010B	80	120	20	75	125	20
Potassium	7440-09-7	6010B	80	120	20	75	125	20
Selenium	7782-49-2	6010B	80	120	20	75	125	20
Silver	7440-22-4	6010B	80	120	20	75	125	20
Sodium	7440-23-5	6010B	80	120	20	75	125	20
Thallium	7440-28-0	6010B	80	120	20	75	125	20
Vanadium	7440-62-6	6010B	80	120	20	75	125	20
Zinc	7440-66-6	6010B	80	120	20	75	125	20

Table 12-5
Percent Recoveries and RPD's for Metals in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Aqueous Matrix:

Parameters	CAS Number	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
			LCL	UCL		LCL	UCL	
Aluminum	7429-90-5	6010B	80	120	20	75	125	20
Antimony	7440-36-0	6010B	80	120	20	75	125	20
Arsenic	7440-38-2	6010B	80	120	20	75	125	20
Barium	7440-39-3	6010B	80	120	20	75	125	20
Beryllium	7440-41-7	6010B	80	120	20	75	125	20
Boron	7440-42-8	6010B	80	120	20	75	125	20
Cadmium	7440-43-9	6010B	80	120	20	75	125	20
Calcium	7440-70-2	6010B	80	120	20	75	125	20
Chromium	7440-47-3	6010B	80	120	20	75	125	20
Chromium IV	18540-29-9	7196A	80	116	20	34	136	30
Cobalt	7440-48-4	6010B	80	120	20	75	125	20
Copper	7440-50-8	6010B	80	120	20	75	125	20
Cyanide	57-12-5	9012A	69	118	20	42	140	20
Iron	7439-89-6	6010B	77	127	20	75	125	20
Lead	7439-92-1	6010B	80	120	20	75	125	20
Magnesium	7439-95-4	6010B	80	120	20	75	125	20
Manganese	7439-96-5	6010B	80	120	20	75	125	20
Mercury	7439-97-6	7470/7471	70	118	20	53	135	20
Nickel	7440-02-0	6010B	80	120	20	75	125	20
Potassium	7440-09-7	6010B	80	120	20	75	125	20
Selenium	7782-49-2	6010B	80	120	20	75	125	20
Silver	7440-22-4	6010B	80	120	20	75	125	20
Sodium	7440-23-5	6010B	80	120	20	75	125	20
Thallium	7440-28-0	6010B	80	120	20	75	125	20
Vanadium	7440-62-6	6010B	80	120	20	75	125	20
Zinc	7440-66-6	6010B	80	120	20	75	125	20

LCL = Lower Control Limit
UCL = Upper Control Limit
LCS = Laboratory Control Sample
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference

Table 12-6
Percent Recovery and RPD for PCBs in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	CAS Number	Method	LCS %Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
PCBs			**LCL**	**UCL**		**LCL**	**UCL**	
Aroclor 1016	12674-11-2	8082	49	122	39	26	144	39
Aroclor 1221	11104-28-2	8082	0	0	0	0	0	0
Aroclor 1232	11141-16-5	8082	0	0	0	0	0	0
Aroclor 1242	53469-21-9	8082	0	0	0	0	0	0
Aroclor 1248	12672-29-6	8082	0	0	0	0	0	0
Aroclor 1254	11097-69-1	8082	0	0	0	0	0	0
Aroclor 1260	11096-82-5	8082	51	127	33	37	138	33

Aqueous Matrix:

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
PCBs			**LCL**	**UCL**		**LCL**	**UCL**	
Aroclor 1016	12674-11-2	8082	61	118	20	56	119	20
Aroclor 1221	11104-28-2	8082	0	0	0	0	0	0
Aroclor 1232	11141-16-5	8082	0	0	0	0	0	0
Aroclor 1242	53469-21-9	8082	0	0	0	0	0	0
Aroclor 1248	12672-29-6	8082	0	0	0	0	0	0
Aroclor 1254	11097-69-1	8082	0	0	0	0	0	0
Aroclor 1260	11096-82-5	8082	61	124	27	31	138	27

LCL = Lower Control Lomit
UCL = Upper Control Limit
MS/MSD = Matrix/Matrix Spike Duplicates
RPD = Relative Percent Difference

Table 12-6
Percent Recovery and RPD for PCBs in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

LCS = Laboratory Control Sample

Table 12-7
Percent Recoveries and RPD's for Pesticides in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	CAS Number	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Pesticides		**LCL**	**UCL**		**LCL**	**UCL**	
Aldrin	309-00-02	39	122	40	33	122	40
alpha-BHC	319-84-6	31	126	40	30	130	40
beta-BHC	319-85-7	51	110	43	18	116	43
delta-BHC	319-86-8	19	142	34	16	142	34
gamma-BHC (Lindane)	58-89-9	47	130	36	33	130	36
alpha-Chlordane	5103-71-9	32	123	65	26	145	65
gamma-Chlordane	5103-74-2	33	125	36	31	154	36
Chlordane (technical)	57-74-9	0	0	0	0	0	0
4,4'-DDD	72-54-8	22	143	35	19	157	35
4,4'-DDE	72-55-9	27	130	39	49	157	39
4,4'-DDT	50-29-3	35	144	42	23	144	42
Dieldrin	60-57-1	45	128	33	33	133	33
Endosulfan I	959-98-8	24	113	41	17	113	41
Endosulfan II	33213-65-9	35	124	27	21	129	27
Endosulfan sulfate	1031-07-8	22	133	34	22	139	34
Endrin	72-20-8	47	133	38	33	138	38
Endrin aldehyde	7421-93-4	27	130	29	18	153	29
Endrin ketone	53494-70-5	28	115	32	34	137	32
Heptachlor	76-44-8	39	126	44	32	128	44
Heptachlor epoxide	1024-57-3	33	128	43	33	148	43
Isodrin	465-73-6	0	0	0	0	0	0
Methoxychlor	72-43-5	24	161	41	25	164	41
Toxaphene	8001-35-2	0	0	0	0	0	0

LCL = Lower Control Limit
UCL = Upper Control Limit
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference
LCS = Laboratory Control Sample

Table 12-7
Percent Recoveries and RPD's for Pesticides in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters	CAS Number	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Aqueous Matrix:							
Pesticides - SW846/8081		**LCL**	**UCL**		**LCL**	**UCL**	
Aldrin	309-00-02	62	120	33	19	131	33
alpha-BHC	319-84-6	66	131	54	62	133	49
beta-BHC	319-85-7	66	131	54	37	157	54
delta-BHC	319-86-8	63	141	44	36	176	58
gamma-BHC (Lindane)	58-89-9	49	137	22	30	148	22
alpha-Chlordane	5103-71-9	63	126	41	38	140	55
gamma-Chlordane	5103-74-2	63	128	28	36	150	57
Chlordane (technical)	57-74-9	0	0	0	0	0	0
4,4'-DDD	72-54-8	56	144	39	24	179	61
4,4'-DDE	72-55-9	59	135	39	30	146	87
4,4'-DDT	50-29-3	60	140	50	24	145	50
Dieldrin	60-57-1	68	130	37	35	141	37
Endosulfan I	959-98-8	25	120	36	25	120	36
Endosulfan II	33213-65-9	38	120	52	27	134	87
Endosulfan sulfate	1031-07-8	62	126	40	47	143	53
Endrin	72-20-8	46	137	40	28	148	40
Endrin aldehyde	7421-93-4	58	133	54	13	159	97
Endrin ketone	53494-70-5	53	124	44	45	130	55
Heptachlor	76-44-8	57	124	32	25	135	32
Heptachlor epoxide	1024-57-3	63	129	31	57	138	54
Isodrin	465-73-6	0	0	0	0	0	0
Methoxychlor	72-74-5	49	150	29	27	178	64
Toxaphene	8001-35-2	0	0	0	0	0	0

LCL = Lower Control Limit
UCL = Upper Control Limit
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference
LCS = Laboratory Control Sample

Table 12-8
Percent Recoveries and RPD's for Explosives in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	CAS Number	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Explosives			**LCL**	**UCL**		**LCL**	**UCL**	
4-Amino-2,6-dinitrotoluene	19406-51-0	8330	82	115	20	82	115	20
2-Amino-4,6-dinitrotoluene	35572-78-2	8330	81	115	25	81	115	25
1,3-Dinitrobenzene	99-65-0	8330	80	113	20	80	113	20
2,4-Dinitrotoluene	121-14-2	8330	81	116	22	81	116	22
2,6-Dinitrotoluene	606-20-2	8330	80	116	31	80	116	31
HMX	2691-41-0	8330	86	122	20	86	122	20
Nitrobenzene	98-95-3	8330	81	111	20	81	111	20
Nitroglycerin	55-63-0	8330	86	119	50	86	119	50
3-Nitrotoluene	99-08-1	8330	83	113	39	83	113	39
4-Nitrotoluene	99-99-0	8330	81	112	20	81	112	20
2-Nitrotoluene	88-72-2	8330	81	112	46	81	112	46
PETN	78-11-5	8330	82	128	50	82	128	50
RDX	121-82-4	8330	79	109	29	79	109	29
Tetryl	479-45-8	8330	79	113	20	79	113	20
1,3,5-Trinitrobenzene	99-35-4	8330	80	116	20	80	116	20
2,4,6-Trinitrotoluene	118-96-7	8330	82	114	22	82	114	22

LCL = Lower Control Limit
UCL = Upper Control Limit
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference
LCS = Laboratory Control Sample

Table 12-8
Percent Recoveries and RPD's for Explosives in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Aqueous Matrix:

Parameters	CAS Number	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Explosives			**LCL**	**UCL**		**LCL**	**UCL**	
4-Amino-2,6-dinitrotoluene	19406-51-0	8330	85	115	16	85	115	16
2-Amino-4,6-dinitrotoluene	35572-78-2	8330	84	114	17	84	114	17
1,3-Dinitrobenzene	99-65-0	8330	86	116	17	86	116	17
2,4-Dinitrotoluene	121-14-2	8330	84	114	21	84	114	21
2,6-Dinitrotoluene	606-20-2	8330	84	114	17	84	114	17
HMX	2691-41-0	8330	86	120	19	86	120	19
Nitrobenzene	98-95-3	8330	83	116	26	83	116	26
Nitroglycerin	55-63-0	8330	84	114	15	84	114	15
3-Nitrotoluene	99-08-1	8330	78	116	29	78	116	26
4-Nitrotoluene	99-99-0	8330	80	115	30	80	115	30
2-Nitrotoluene	88-72-2	8330	80	113	31	80	113	31
PETN	78-11-5	8330	85	118	15	85	118	15
RDX	121-82-4	8330	83	113	15	83	113	15
Tetryl	479-45-8	8330	83	113	17	83	113	17
1,3,5-Trinitrobenzene	99-35-4	8330	83	114	26	83	114	26
2,4,6-Trinitrotoluene	118-96-7	8330	78	119	24	78	119	24

LCL = Lower Control Limit
UCL = Upper Control Limit
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference
LCS = Laboratory Control Sample

Table 12-9
Percent Recoveries and RPD's for Methane, Ethane, Ethene, and Perchlorate in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Parameters	CAS Number	Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Methane,Ethane,Ethene			**LCL**	**UCL**		**LCL**	**UCL**	
Methane	74-82-8	RSK-175	70	130	30	70	130	30
Ethane	74-84-0	RSK-175	70	130	30	70	130	30
Ethene	74-85-1	RSK-175	70	130	30	70	130	30

Parameters		Method	LCS % Recovery		LCS % RPD	MS/MSD % Recovery		MS/MSD % RPD
Perchlorate			**LCL**	**UCL**		**LCL**	**UCL**	
Perchlorate	14-97-73-0	8321A	35	135	50	35	135	50

LCL = Lower Control Limit
UCL = Upper Control Limit
MS/MSD = Matrix Spike/Matrix Spike Duplicate
RPD = Relative Percent Difference
LCS = Laboratory Control Sample

Table 4-1
Sample Containers/Preservatives/Holding Times for Aqueous Matrix Samples
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

ANALYSES	TYPE OF INSTRUMENT	SAMPLE CONTAINERS	PRESERVATIVES	EXTRACTION/ANALYSIS HOLDING TIME*
TAL Metals + Boron (6010B/7470A)	ICP/CVAA	Total: 1 x 1 Liter Plastic	Store at 4°C; HNO_3, pH<2 for total sample	6 mo./ (28 days Hg)
		Dissolved: 1 x 1 Liter Plastic	Store at 4°C; HNO_3 (Preserve dissolved sample after filtering to pH<2)	6 mo./ (28 days Hg)
TCL Volatile Organic Compounds (8260)	Gas Chromatograph/ Mass Spec	3 x 40 ml vials; no headspace	Store at 4°C; HCL pH<2	14 days
TCL Semi-Volatile Organic Compounds (8270C)	Gas Chromatograph/ Mass Spec	2 X 1 Liter Amber Glass	Store at 4°C	7 days/40 days
Organochlorine Pesticides (8081A)	Gas Chromatograph	2 X 1 Liter Amber Glass	Store at 4°C	7 days/40 days
Organophosphorous Pesticides (8141A)	GC/FPD and GC/MS	2 X 1 Liter Amber Glass	Store at 4°C	7 days/40 days
Polychlorinated Biphenyls (8082)	Gas Chromatograph	2 X 1 Liter Amber Glass	Store at 4°C	7 days/40 days
Polynuclear Aromatic Hydrocarbons (PAHs)(8270C SIM)	Gas Chromatograph/ Mass Spec	2 X 1 Liter Amber Glass	Store at 4°C	7 days/40 days
Dioxin/Furan (8290)	High Resolution Gas Chromatograph/High Resolution Mass Spectrometer	2 X 1 Liter Amber Glass	Store at 4°C	7 days/40 days
Explosives + Nitroglycerin & PETN (8330)	LC/MS	2 X 1 Liter Amber Glass	Store at 4°C	7 days/40 days
Cyanide (Total) (9012A)	Autoanlayzer	250 ml Plastic	Store at 4°C; NaOH, pH >12	14 days
Ammonia (350.3)	Ion Selective Electrode	250 ml Plastic	Store at 4°C; H_2SO_4 pH <2	28 days
Nitrate-Nitrite (353.2)	Autoanalyzer	250 ml Plastic	Store at 4°C; H_2SO_4 pH <2	28 days
Total Phosphorous/Orthophosphate (365.2)	Spectrophotometer	250 ml Plastic	Store at 4°C	28 days
Methane/Ethane/Ethene (RSK-175)	Gas Chromatograph	2 x 40 ml vials; no headspace	Store at 4°C; HCL pH <2	14 days
Sulfide (376.1)	Manual Titration	500 ml Plastic	Store at 4°C; ZnOAc/NaOH pH>9	7 days
Sulfate (300.0)	Ion Chromatograph	250 ml Plastic	Store at 4°C	28 days
Alkalinity (310.1)	pH Meter	250 ml Plastic	Store at 4°C	14 days
Total Dissolved Solids (TDS) (160.1)	Analytical Balance and Filters	250 ml Plastic	Store at 4°C	7 days
Perchlorate (8321A)	Ion Chromatograph	250 ml Plastic	Store at 4°C	28 days
Total Suspended Solids (TSS) (160.2)	Analytical Balance and Filters	250 ml Plastic	Store at 4°C	7 days

* Extraction and analysis holding times are calculated from the date and time of sample collection.

Table 4-2
Sample Containers, Preservatives and Holding Times for Solid Matrix Samples
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

ANALYSES	SAMPLE CONTAINERS[2]	PRESERVATIVES	EXTRACTION/ANALYSIS HOLDING TIME[1]
TAL Metals + Boron (Total) (6010B/7471A)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	6 mo./ (28 days Hg)
TCL Volatile Organic Compounds (8260B)*	3 Encores; 7 MS/MSD	Store at 4°C; freeze within 48 hours	14 Days
TCL Semi-Volatile Organic Compounds (8270C)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days/40 Days
Organochlorine Pesticides (8081A)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days/40 Days
Organophosphoros Pesticides (8141A)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days/40 Days
Polychlorinated Biphenyls (8082)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days/40 Days
Polynuclear Aromatic Hydrocarbons (8270C SIM)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days/40 Days
Explosives + Nitroglycerin & PETN (8330)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days/40 Days
Cyanide (Total) (9012A)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days
Nitrate-Nitrite (353.2)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days
Sulfate (300.0)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days
Total Phosphorous-Orthophosphate (365.2)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days
Perchlorate (8321A)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days
Dioxin/Furan (8290)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days/40 Days
Alkalinity (310.1)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days
Total Organic Carbon (Walkley Black Method)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	28 Days
pH (9045C)	4 oz jar -soil/8 oz jar sediment	Store at 4°C	14 Days
Permeability (ASTM D5084-90)	Shelby Tube	NA	NA
Grain Size (ASTM D422)	Shelby Tube	NA	NA

* = Samples to be analyzed as soils under 8260 will be collected in Encore devices and frozen within 48 hours of collection;
Sediment samples analyzed under 8260 will be collected in 2 oz. squat jars.

NA = not applicable

[1] Extraction and analysis holding times are calculated from the date and time of sample collection.

[2] When multiple tests are conducted at one location samples will be combined;
All tests can be completed using one (1) 500 ml widemouth jar; three (3) 500ml widemouth jars for sediment.

Table 6-1
Summary of Field Monitoring Instruments
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Sample Matrix	Field Parameters	[1]Field Instruments	Sensitivity	Optimum Range
Soil	VOCs	PID (Hnu Model PI-101)	0.5 ppm	Background to 2,000 ppm
	Lithology	Visual	-	-
Sediment	Physical Description	Visual	-	-
Groundwater	pH	pH probe (YSI Model 5565)	0.01 units	0.00 to 14.00
	Conductivity	Conductivity probe (YSI Model 5563)	0.001 mS/cm	0 to 200 mS/cm
	Temperature	Temperature meter (YSI Model 5563)	0.01 C	-5 to +45 ^{o}C
	Dissolved Oxygen	DO meter (YSI Model 5563)	0.01 mg/L	0.2 to 20 mg/L
	ORP	ORP probe (YSI Model 5565)	0.1 mV	-999 to +999 mV
	Turbidity	Turbidity Meter (HF Scientific Model DRT-15C)	0.01 NTU	0-20; 0-200 NTU
	Water Level	Water Level or Interface Meter	-	-
Surface Water	pH	pH/cond./temp. meter	TBD	TBD
	Conductivity	pH/cond./temp. meter	TBD	TBD
	ORP	ORP meter	TBD	TBD
	Temperature	Temperature Meter (YSI 55 Probe)	± 0.2^{o}C	-5 to +45 oC
	Dissolved Oxygen	DO Meter (YSI 55 Probe)	± 0.3 mg/L	0 to 20 mg/L

TBD - To Be Determined

[1] All field instruments will be calibrated at a minimum frequency of once daily and recalibrated if the operator suspects the instrument is malfunctioning.

Table 6-2
Surrogate Percent Recovery for Volatiles in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	% Recovery	
Volatiles Surrogates - SW846/8260	**LCL**	**UCL**
4-Bromofluorobenzene	47	158
1,2-Dichloroethane-d4	61	130
Toluene-d8	60	143
Dibromofluoromethane	59	138

Aqueous Matrix:

Parameters	% Recovery	
Volatiles Surrogates - SW846/8260	**LCL**	**UCL**
4-Bromofluorobenzene	74	116
1,2-Dichloroethane-d4	61	128
Toluene-d8	76	110
Dibromofluoromethane	73	122

LCL = Lower Control Limit
UCL = Upper Control Limit

Table 6-3
Surrogate Percent Recovery for Semi-Volatiles in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	% Recovery	
Semi-Volatiles Surrogates - SW846/8270	**LCL**	**UCL**
2-Fluorobiphenyl	43	110
2-Fluorophenol	11	116
2,4,6-Tribromophenol	35	116
Nitrobenzene-d5	42	110
Phenol-d5	25	115
Terphenyl-d14	37	137

Aqueous Matrix:

Parameters	% Recovery	
Semi-Volatiles Surrogates - SW846/8270	**LCL**	**UCL**
2-Fluorobiphenyl	30	110
2-Fluorophenol	13	110
2,4,6-Tribromophenol	21	122
Nitrobenzene-d5	32	112
Phenol-d5	10	113
Terphenyl-d14	10	144

LCL = Lower Control Limit
UCL = Upper Control Limit

Table 6-4
Surrogate Percent Recovery for PCBs in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site AUS OU

Solid Matrix:

Parameters	% Recovery	
PCBs Surrogates - SW846/8082	**LCL**	**UCL**
Decachlorobiphenyl	23	141
Tetrachloro-m-xylene	31	127

Aqueous Matrix:

Parameters	% Recovery	
PCBs Surrogates - SW846/8082	**LCL**	**UCL**
Decachlorobiphenyl	24	128
Tetrachloro-m-xylene	45	120

LCL = Lower Control Limit
UCL = Upper Control Limit

Table 6-5
Surrogate Percent Recovery for Pesticides in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	**% Recovery**	
Pesticides Surrogates - SW846/8081	**LCL**	**UCL**
Decachlorobiphenyl	18	145
Tetrachloro-m-xylene	31	131

Aqueous Matrix:

Parameters	**% Recovery**	
Pesticides Surrogates - SW846/8081	**LCL**	**UCL**
Decachlorobiphenyl	31	115
Tetrachloro-m-xylene	47	110

LCL = Lower Control Limit
UCL = Upper Control Limit

Table 6-6
Surrogate Percent Recovery for Explosives in Solid and Aqueous Matrices
Crab Orchard National Wildlife Refuge NPL Site - AUS OU

Solid Matrix:

Parameters	% Recovery	
Explosives Surrogates - SW846/8330	**LCL**	**UCL**
3,4-Dinitrotoluene	86	105
2,4-Dinitrofluorobenzene	61	135

Aqueous Matrix:

Parameters	% Recovery	
Explosives Surrogates - SW846/8330	**LCL**	**UCL**
3,4-Dinitrotoluene	78	103
2,4-Dinitrofluorobenzene	72	130

LCL = Lower Control Limit

UCL = Upper Control Limit

APPENDIX B

Chain of Custody and Custody Seal

Chain of Custody Record

SEVERN
TRENT
SERVICES

Severn Trent Laboratories, Inc.

STL-4124 (0901)

Client	Project Manager	Date	Chain of Custody Number 157501
Address	Telephone Number (Area Code)/Fax Number	Lab Number	**Page** ____ **of** ____
City / State / Zip Code	Site Contact / Lab Contact		
Project Name and Location (State)	Carrier/Waybill Number		
Contract/Purchase Order/Quote No.			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix					Containers & Preservatives						Analysis (Attach list if more space is needed)												Special Instructions/ Conditions of Receipt
			Air	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH													

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other ____________

QC Requirements (Specify)

1. Relinquished By	Date	Time	1. Received By	Date	Time
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

CUSTODY SEAL

DATE ______________________

SIGNATURE ______________________

QEC
Quality Environmental Containers
800-255-3950 • 304-255-3900

CLIENT LABEL

Client: ______________________ **Date:** ______________

Site: ______________________ **Time:** ______________

Sample ID: ______________________

Analysis: ______________________

Signature: ______________________

QUA-9022 (1098)

Select laboratory information is subject to a claim of confidential business information. Selected pages in this pdf (00059881) from electronic page range 374 – 948 (end) have been withheld in their entirety while FWS evaluates the claim.

Page Inserted May, 2006