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US Army Corps of Engineers

Prepared for:

Department of the Army
Nashville District, Corps of Engineers
Nashville, Tennessee

Final Site Wide Sampling and Analysis Plan

Former Plum Brook Ordnance Works
Sandusky, Ohio

Contract DACW62-03-D-0004-0002

May, 2004

Prepared by:

Jacobs Engineering Group Inc.
125 Broadway Avenue
Oak Ridge, Tennessee 37830

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May 7, 2004

Attn: CELRN-EC-R-M (Linda Ingram)
U.S. Army Corps of Engineers
Nashville District
110 Ninth Ave. South, Rm. 682 Annex
Nashville, TN 37203

Subject: Plum Brook Ordnance Works Work Plans - Final

Dear Linda,

Enclosed find four (4) copies of the following documents:

1. Site-wide Safety and Health Plan – Final
2. Site-wide Sampling and Analysis Plan – Final
   - -Quality Assurance Project Plan
   - -Field Sampling Plan
3. Site-specific Safety and Health Plan – Final
4. Site-specific Sampling and Analysis Plan – Final
   - -Quality Assurance Project Plan
   - -Field Sampling Plan

These documents are required deliverables for Contract DACW62-03-D-0004-0002, "Reservoir No. 2 Burning Ground, Remedial Investigation Part 1: Site Characterization at the Former Plum Brook Ordnance Works, Sandusky, Ohio".

As you are aware, we are planning mobilization for the soil investigation work on 5/17/04 with the fieldwork occurring from 5/18 thru 5/24. If you have any question, please contact me.

Sincerely yours,

Virgil W Jansen

Virgil W. Jansen

Attachments

JACOBS

Cc: ✓Rick Meadows-CELRH (3 copies)
Archie Lunsey-OEPA (2 copies)
Laurie Moore-OEPA (1 copy)
Robert Lallier-NASA (2 copies)
Michael Filips-CENWO (1 copy)
Dennis Druck-USCHPPM (1 copy)
Mark Bohne-PBOW RAB (1 copy)

FINAL SITE WIDE FIELD SAMPLING PLAN

FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

Prepared for:

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE
CONTRACT DACW62-03-D-0004-0002

Prepared by:

JACOBS ENGINEERING
Engineers and Constructors

JACOBS ENGINEERING GROUP, INC.
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May, 2004

COMPLETION OF INDEPENDENT TECHNICAL REVIEW

Jacobs Engineering Group, Inc. has completed the **Final Site-Wide Field Sampling Plan** for **Site Characterizations at the Former Plum Brook Ordnance Works, Sandusky, Ohio.** Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project, as defined in the Quality Control Plan. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy.

Mike Hanch by russ	Chemist	5/5/04
(Signature)	(Discipline)	(Date)

Independent Technical Review Team Leader and Team Members

(Signature)	(Discipline)	(Date)

Independent Technical Review Team Leader and Team Members

(Signature)	(Discipline)	(Date)

Independent Technical Review Team Leader and Team Members

Al Hardesty	Hydrogeologist	May 5, 2004.
(Signature)	(Discipline)	(Date)

JE Site-Wide FSP Author

CERTIFICATION OF INDEPENDENT TECHNICAL REVIEW

Significant concerns and the explanation of the resolution are as follows (Describe the major technical concerns, possible impact, and resolution):

Comment: All comments on draft require review.
Resolution: Response to Comments (RTC) are included as Appendix A. All modifications, as per RTC, are incorporated.

Comment:

Comment:

Comment:

Comment:

All concerns resulting from independent technical review of the project have been considered.

Virgil W Jones (Signature) 5/5/05 (Date)

(Project Manager)

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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	area of known contamination
AR/COC	Analysis Request/Chain of Custody Record
ASTM	American Society for Testing and Materials
bgs	below ground surface
BNA	base/neutral and acid extractables
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
°C	degrees Celsius
DERP	Defense Environmental Restoration Program
DM	Dames & Moore
DNT	dinitrotoluene
DOD	U.S. Department of Defense
DQO	data quality objective
EA	Environmental Assessment
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
ft/day	feet per day
gpm	gallons per minute
GPR	ground penetrating radar
GSA	General Services Administration
IDW	investigation-derived wastes
JE	Jacobs Engineering Group, Inc.
MCL	maximum contaminant level
MCLG	MCL goal
MHz	megahertz
mS/m	millisiemen per meter
msl	mean sea level
NASA	National Aeronautics and Space Administration
NAVD	North American Vertical Datum
N-S	north to south
NTU	Nephelometric Turbidity Units
OEPA	Ohio Environmental Protection Agency
OHARNG	Ohio Air Reserve National Guard
OVA	organic vapor analysis
PBOW	Plum Brook Ordnance Works
PBS	Plum Brook Station
PCB	polychlorinated biphenyls
PID	photoionization detector
PM	project manager
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QCP	Quality Control Plan
RBC	risk based criteria
SAP	Sampling and Analysis Plan

SAPA	Sapling and Analysis Plan Addendum
SHP	Safety and Health Plan
SWSAP	Site-Wide Sampling and Analysis Plan
TNT	trinitrotoluene

1.0 INTRODUCTION

The U.S. Army is conducting studies of the environmental impact of suspected hazardous waste sites at previously owned U.S. Department of Defense (DOD) properties. This work is being performed by the U.S. Army Corps of Engineers (USACE) under the Defense Environmental Restoration Program (DERP). The Plum Brook Ordnance Works (PBOW) site, located in Sandusky, Erie County, Ohio (Figure 1-1), is a formerly used defense site under DERP, currently being managed and technically overseen by the Nashville, Tennessee USACE District Office. Work contracted to Jacobs Engineering Group (JE) includes providing engineering services to conduct environmental investigations at PBOW, including soil, sediment, surface water, and groundwater.

This Sitewide Sampling and Analysis Plan (SAP) has been prepared as a leading document for the work to be carried out in support of all future investigations at PBOW. This SAP is intended for use by JE project team members as the guide and reference source for specific investigations at PBOW for various issues including data acquisition and management, data quality objectives (DQO), investigative methodologies, laboratory quality assurance (QA), and nonconformances and corrective actions. The SAP contains plans and general procedures for all work to be performed at the former PBOW sites and details specific to each of the investigations will be included in site-specific attachments to this document. A Sitewide Safety and Health Plan (SHP) has been prepared to provide guidance and procedures for issues related to the safety and health of project personnel and the environment. A Quality Assurance Project Plan (QAPP) has been prepared to provide assurance that work to be performed at PBOW will be of the quality required to satisfy the project objectives and is responsive to the applicable regulatory requirements. A Quality Control Plan (QCP) has also been prepared for the purpose of identifying authorities and responsibilities among project team members to ensure implementation and management of the project.

1.1 SITE HISTORY AND CONTAMINANTS

The 9,009-acre PBOW site was built in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Production of explosives began in December 1941 and continued until 1945. It is estimated that more than one billion pounds of explosives were manufactured during the 4-year operating period.

After the plant was shut down, decontamination of TNT, acid, pentolite, and DNT processing lines began; decontamination was completed during the last quarter of 1945. The property was initially transferred to the Ordnance Department, then to the War Assets Administration after it was certified by the U.S. Army to be decontaminated. In 1949, PBOW was transferred to the General Services Administration (GSA).

The National Aeronautics and Space Administration (NASA) acquired the PBOW in 1963 and is presently utilizing the site. On April 18, 1978, NASA declared approximately 2,152 acres of land as excess. The Perkins Township Board of Education acquired 46 acres of the excess land for use as a bus transportation center. GSA retains the remaining acreage and currently has a use agreement with the Ohio National Guard for 604 acres of the land. NASA presently controls about 6,400 acres for conducting space research as a satellite operation (Plum Brook Station [PBS]) of NASA's Lewis Research Center located in Cleveland, Ohio. The details of these land transactions are listed in the Site Management Plan archived at the PBS.

Numerous areas of concern (AOC) have been identified at PBOW (Figure 1-2). The most common contaminants exceeding the RBCs at these sites are SVOCs, primarily nitroaromatics, which have been detected in surface soil, subsurface soil, shallow groundwater, and to a lesser extent in bedrock groundwater. Additional contaminants in soil include PCBs, and inorganics.

1.2 SUMMARY OF EXISTING SITE CHARACTERISTICS

PBOW is located approximately 4 miles south of Sandusky, Ohio within the Perkins and Oxford Townships. The site is bounded on the north by Bogart Road, on the south by Mason Road, on the east by U.S. Highway 250, and on the west by County Road 43. The former PBOW site consists of 9,009 acres and lies in an area that is primarily rural and agricultural with low population density.

There are approximately 106 permanent buildings and structures and 99 munitions bunkers located in the southeast portion of the site. These bunkers were constructed during the PBOW operation and some are currently used by NASA PBS for the storage of materials, equipment, and records. Electric power is provided to the facility by the Ohio Edison Company. Potable water is supplied by the City of Sandusky. NASA PBS has five wastewater treatment systems, three of which are currently operating.

1.2.1 Physical Setting

1.2.1.1 Climate

The climate in northern Ohio is continental in nature but shows strong influence from Lake Erie. The weather changes frequently due to warm and cold air fronts moving through the area. Summer in Sandusky is warm and humid with high temperatures rarely exceeding 100 degrees Fahrenheit (°F). Winters are cold and windy. On an average, the temperature first falls to below freezing in October and the last freezing temperature occurs in April. Mean annual precipitation is calculated at 33.9 inches based on data from 1951 to 1980. The wind direction is southwest 55 percent of the time.

1.2.1.2 Topography

Surface deposits in the area surrounding the PBOW were formed from glacial and lacustrine processes, resulting in a relatively flat topography. The ground surface slopes gradually northward toward Lake Erie. Elevations at the PBOW site range from 675 feet above mean sea level (msl) at the southwest edge of the site to 625 feet msl in the northern portion of the property at Bogart Road.

1.2.1.3 Regional Geology

Bedrock consists of Paleozoic sedimentary rocks that range from Ordovician to Permian age. Ordovician bedrock in Ohio is mostly calcareous shale, argillaceous, cherty limestone, and fine clastic rocks. Silurian bedrock in Ohio consists of carbonated rocks (limestone and dolomite) with evaporates and dolomite that grades into shale in the upper part of the Silurian sequence. The Lower and Middle Devonian rocks are predominantly limestone, while the upper Devonian consists of the Ohio and Olentangy shales. According to Ohio Geological Survey open-file map, the PBOW site is underlain from west to east by Devonian formations including Delaware limestone, Plum Brook shale, Prout limestone, and Ohio shale. The limestones are massive

with calcareous shale partings and are moderately porous with high secondary permeability near the soil/rock interface, while the shale deposits are low in porosity. Depth to bedrock varies considerably on site. A monitoring well installed near the reactor facility encountered limestone bedrock at a depth of 25 feet below ground surface (bgs). Another well installed in the vicinity of red water pond in the western portion of the site, encountered limestone at a depth of 19 feet bgs. Shale bedrock in the southern portion of the site has been encountered during drilling at depths of 2 to 12 feet.

The Findley Arch dominates the regional structure in northwestern Ohio. PBOW is on the southeast side of the arch with bedrock dipping to the southeast at about 5 to 10 feet per mile.

1.2.1.4 Soil

The surficial and near-surface deposits were produced by glacial and lacustrine processes. The dominant soil materials were deposited as glacial till, outwash, and lacustrine deposits.

The U.S. Department of Agriculture Soil Conservation Service Soil Survey (1971) identifies the majority of soils at the site as being from the Arkport-Galen association. Arkport soils consist of gently sloping to moderately sloping, well-drained soils formed in the sandy material deposited at the edge of a glacial lake. Arkport soils are generally loamy fine sand and fine sand. Galen soils are mostly level and moderately well drained, formed as small sandy deposits on outwash plains and deltas. Galen soils have a fine sand or sandy loam surface layer, a subsurface of fine sand and loamy fine sand that is underlain by silt or clay. The southern portion of the site has soils of the Prout association. Prout soils are moderately deep to deep, nearly level to gently sloping, somewhat poorly drained soils that have a subsoil of heavy silt loam to silty clay loam. These soils are commonly found on highlands.

1.2.1.5 Surface Drainage

There are numerous surface ponds and streams in the area surrounding PBOW. Lake Erie and Sandusky Bay are the largest surface water bodies near PBOW. Eleven streams, six of which originate within the PBOW site boundaries, flow northerly or northeasterly into Lake Erie. Plum Brook and Pipe Creek originate south of the site and flow independently into Lake Erie, east and west of the Sandusky airport, respectively. Kuebeler Ditch, Ohlemacher Ditch, Scherer Ditch, and Zorn Beutal Ditch originate at the southwest edge of the property and connect into Harris Ditch south of Fox Road. In addition, 17 isolated ponds and reservoirs and three red water ponds are located on site. Water levels in these ponds remain high during dry season indicating contribution from shallow groundwater.

1.2.1.6 Groundwater

Groundwater in the PBOW area receives its recharge mainly from precipitation. The underlying limestone beds are the principal aquifer. Well yields from the limestone aquifer generally range from 5 to about 25 gallons per minute (gpm). Water in the limestone beds occurs principally in joints and bedding planes or in solutionally enlarged openings. U.S. Geological Survey (USGS) (1992) conducted a hydrogeological study of the glacial deposits in Sandusky in 1990 and reported a horizontal hydraulic conductivity of 0.046 foot per day (ft/day) and a vertical hydraulic conductivity of 1.2 ft/day. Regional groundwater flow is toward Lake Erie. Locally, groundwater flow regime may be different due to local topography.

1.2.2 Previous Environmental Studies

A number of environmental investigations have been completed at the PBOW site. The purpose of these investigations were to address environmental contamination related to past DOD operations. The following section briefly summarizes the findings of these investigations.

Ohio Environmental Protection Agency (OEPA) Preliminary Site Assessment. According to the site inspection report by Morrison Knudsen Corporation (MK), OEPA conducted a preliminary assessment of PBS in 1983 in response to a 1981 spill of about 170 gallons of polychlorinated biphenyls (PCB) at Building 9206 and reported red water discharge from the red water ponds. Soil samples were found to contain PCBs at concentrations up to 2,400 parts per million (ppm). Monitoring wells were installed to evaluate groundwater contamination around the building. Several years of groundwater monitoring showed no evidence of contamination. Monitoring was discontinued in 1990.

Ohio Air Reserve National Guard Environmental Assessment. In the 1980's, the Ohio Air Reserve National Guard (OHARNG) conducted an Environmental Assessment (EA) of the western portion of the site. However, the results of this EA are not currently available.

International Technology Contamination Evaluation. In 1989, International Technology (IT) conducted a Contamination Evaluation under contract to USACE. The evaluation consisted of a record review, site visit, and field sampling and analysis. The areas investigated included waste disposal area No. 1 (also known as Pentolite Road red water ponds), Waste Disposal Area No. 2 (also known as west area red water ponds), Scheid Road Burning Grounds (also known as Snake Road burn ground), and Rubbish Burning Grounds (also known as Taylor Road burn ground). Four groundwater monitoring wells were installed and sampled. In addition, 21 soil samples and 4 surface water samples were also collected and analyzed. Samples were analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), nitroaromatic compounds, nitrates, sulfates, pH, and metals. The results of this contamination evaluation indicated no soil or groundwater contamination by VOCs at any locations sampled, limited soil and groundwater contamination from SVOCs at the Waste Disposal Area No. 1 and the Scheid Road Burning Grounds. Elevated metals, sulfates, and nitrates in soils at Waste Disposal Area No. 1, and elevated metals in groundwater at the Waste Disposal Area No. 2 were also detected.

H^+GLC Snake Road Burn Ground Investigation. In 1992, H^+GLC conducted an SI of the Snake Road burn ground and the adjacent burn grounds used by NASA. The purpose of the investigation was to characterize possible groundwater and surface water contamination from use of this area as an uncontrolled burn ground. Groundwater monitoring wells and soil borings were installed to allow collection of characteristic samples. Based on the results of the investigation, H^+GLC recommended no further site characterization or remediation of the site.

Morrison Knudsen Corporation Site Inspection. In 1994, MK completed an SI of the PBS for NASA in order to perform a hazard ranking for the site. The MK investigation included review of existing environmental data, collection and analysis of surface soil, sediment, surface water, and groundwater samples. All samples were analyzed for organic and inorganic compounds. In addition, a small number of samples from various site media also were collected and analyzed for radioactivity. The results of the MK investigation identified limited contamination in multiple areas of the PBOW site, some of which were previously used during PBOW operation. However, the Hazard Ranking Score for the overall site was below Comprehensive

Environmental Response, Compensation, and Liability Act (CERCLA) action levels.

Dames & Moore Sitewide Groundwater Investigation. Dames & Moore (DM) conducted a sitewide groundwater investigation in 1994 (DM, 1996) under contract to Nashville USACE to evaluate groundwater flow conditions in both the overburden and bedrock aquifers and to investigate baseline groundwater quality of the bedrock aquifer. Eleven shallow monitoring wells and eight deep (bedrock) wells were installed and sampled. All samples were analyzed for explosives, nitrates, and total and dissolved metals. Samples from bedrock wells were also analyzed for VOCs and base/neutral and acid extractables (BNA). The results of the DM investigation indicate that significant levels of explosive residues are present in the shallow groundwater in the vicinity of both former red water pond areas. Low levels of explosives and several VOCs and BNAs were also detected in bedrock wells.

IT Corporation Site Investigations. IT conducted site investigations in 1996 at the Reservoir No. 2 Burning Ground (2BG), Additional Burning Ground, Wastewater Disposal Plant No. 2 (WP2), and Power House No. 2 Ash Pit. These investigations included geophysical surveys, trenching, and surface and subsurface soil sampling. The results of the investigation indicate that SVOCs were present above risk based criteria (RBCs) at all sites, nitroaromatic compounds were detected above RBC's at 2BG, and metals were detected above RBC's at four of the sites. It was recommended that additional investigations be conducted at 2BG and WP2 to determine the extent of contamination.

Shaw Environmental 2002 Groundwater Data Summary and Evaluation. Shaw conducted a site-wide groundwater investigation, compiling past analytical results and collecting additional groundwater data during multiple events in 2001 and 2002. During this investigation, ten new bedrock monitoring wells and six temporary piezometers were installed and tested at various AOCs across the site. Groundwater samples, water level data, and hydraulic properties were collected from new and existing monitoring wells. The study indicates that the shallow groundwater and bedrock aquifer have been impacted by site contaminants, including VOCs, SVOCs, PAHs, nitroaromatics, and metals.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The project team will consist of JE and JEs approved subcontractors.

The JE team has identified key management and technical personnel who will participate in this program. The program manager, Virgil Jansen (professional engineer) will have the authority and responsibility for contract management. Virgil Jansen will also serve as the project manager (PM) and will be responsible for overall project execution and allocation of resources necessary to implement the work plan and SHP. The principal technical lead and site manager, Al Hardesty (registered professional geologist) will coordinate multidisciplinary investigation efforts and ensure efficient and effective information transfer among team members and be responsible for the technical quality of the project. Sean Healey will serve as the safety and health officer and be responsible for safety and health issues encountered during the execution of the fieldwork. Mike Houck, the analytical coordinator, will coordinate field sampling needs and serve as liaison between the project team and the analytical laboratory. Resumes for these key project personnel have been submitted in the QCP. Other key JE associates are identified within the organization and will serve in their respective roles for the completion of this investigation effort.

JE services to be used for this work are primarily located in Oak Ridge, Tennessee and are:

- Program Management
- Project Management
- Site Investigation Management
- Health and Safety
- Quality Assurance (QA/QC)
- Contract Administration
- Data Management
- Risk Assessment
- Analytical Coordination / Data Analyst

Guidance will be provided to individuals and their activities will be coordinated by the project manager to ensure that overall program goals and objectives are met. Additional JE technical staff will be available throughout the course of all projects at the PBOW. The project manager will determine needs as they arise and obtain the appropriate resources accordingly. Individuals responsible for the field activities will be specifically identified in the site-specific attachments.

3.0 SCOPES AND OBJECTIVES

3.1 TASK DESCRIPTION

JE has been tasked with providing environmental investigation services for PBOW through the USACE, Nashville District. Investigation services will include, but are not limited to, soil, groundwater, surface water and sediment characterization. Each investigation will consist of the following subtasks: preparation and completion of site-specific work plans; completion of various field activities; evaluation of analytical results from samples collected during field investigation; and preparation and submittal of investigation reports of activities, conclusions, and recommendations for further actions. The specific scope of each investigation will be addressed in the individual site-specific attachments, which will be submitted as addenda to this document.

The purpose of these investigations is to collect information on contamination of site media resulting from past activities. Sufficient data will be collected to make management decisions and for developing more detailed and comprehensive sampling regimens should further investigations be necessary. The specific objectives of each investigation will be addressed in the site-specific attachments.

Data Quality Objectives (DQOs) will be developed for each project in accordance with the U.S. Environmental Protection Agency (EPA) guidance document entitled Guidance for the *Data Quality Objectives Process* (EPA QA/G-4) (EPA, 1994) and *Data Quality Objectives Process for Hazardous Waste Site Investigations* (EPA QA/G-4HW) (EPA, 2000).

The DQO process is a series of planning steps based on the Scientific Method that is designed to ensure that the type, quality, and quantity of environmental data used in decision-making are appropriate for the intended application. DQOs are qualitative and quantitative statements derived from outputs of each step of the DQO process that:

- Clarify the study objective.
- Define the most appropriate type of data to collect.
- Determine the most appropriate conditions from which to collect the data.

The DQOs are then used to develop a scientific and resource-effective sampling design. The DQO process allows decision makers to define their data requirements and acceptable levels of uncertainty for each decision during the planning stage and before data are collected. Project-specific DQOs will be developed and presented in the site-specific attachments.

The intended data users and available data related to the PBOW investigations will be considered in order to formulate site-specific conceptual models for each site. Data end users include the EPA, the OEPA, the USACE, NASA PBS, and JE (or other support contractors). These investigations also have been designed to provide the USACE with the level of defensible data required to determine the existence and nature of site contamination and to assess potential risks to human health and the environment. This planning document along with any attachments are designed to give the regulatory agencies sufficient detail to reach a determination as to the adequacy of the plan.

3.2 APPLICABLE REGULATIONS/STANDARDS

EPA Region IX Preliminary Remediation Goals (PRG) will be used to determine contaminants of potential concern (COPCs) and to define the required analytical detection limits for the various investigations.

Analytical data will be evaluated using EPA Region IX PRGs. PRGs are media-specific contaminant levels used to reduce the list of detected chemicals to those warranting further consideration. PRGs are calculated using toxicity data and standard risk-assessment exposure scenarios to derive concentrations of fixed levels of risk. The PRGs correspond to either a hazard quotient of 1 or an excess lifetime cancer risk of 10^{-6}, whichever is the lower concentration. The cancer risk of 10^{-6} reflects the lower end of the target risk range as defined in the National Contingency Plan (EPA, 1990). Chemicals present in environmental media at concentrations below the PRGs are not expected to contribute significantly to total site risk.

Monitor well installation will adhere to the State of Ohio, *Technical Guidance for Well Construction and Ground Water Protection*, 2000 and the USACE EM-1110-1-4000, Monitoring Well Design, Installation, and Documentation, 1998.

3.3 PROJECT SCHEDULE

Each investigation conducted under this SWSAP will involve a similar set of project milestones and project activities, which will have a project-specific schedule. These activities will include the following components:

- preparation and submittal of draft site –specific attachments (SHP,SAP)
- preparation and submittal of final site-specific attachments
- field investigation / data collection activities
- off-site laboratory analysis of collected samples
- preparation and submittal of draft site characterization reports
- preparation and submittal of final site characterization reports

The duration for activities will vary depending on the level of effort for each specific project. In general, two months will be allotted for the review of draft site-specific attachments and the subsequent preparation of final versions. Off-site laboratory analysis will usually be completed 30 days following the conclusion of field investigation activities. Actual dates and durations for each project will be provided in the SSAP Addenda.

4.0 NONMEASUREMENT DATA ACQUISITION

Nonmeasurement data acquisition may include the use of data collected from prior investigations at the various AOCs within the PBOW. Prior to the use of existing chemical data, the data quality will be evaluated to ensure that it meets the current quality requirements for the intended use.

Meteorological data may be obtained from a local source in support of future aquifer tests, which will be addressed in the Site-Specific Attachments.

5.0 INVESTIGATION METHODOLOGIES

This chapter describes the methodologies and procedures to be followed for performance of proposed tasks necessary for conducting site investigations at the PBOW. The investigations will include one or more of the following main tasks:

- geophysical surveys
- groundwater monitoring well installation, development, and sampling
- aquifer testing / hydraulic properties
- soil borings with associated soil sampling
- rock coring and associated documentation and archival
- trenching with associated soil sampling
- surface soil and sediment sampling
- surface water sampling
- land surveying

The rationale for these activities will be provided in the site-specific attachments. The tasks associated with each investigation along with the number of samples to be collected will also be summarized in the site-specific attachments.

5.1 GEOPHYSICAL SURVEYS

Geophysical surveys using magnetometry, electromagnetic (EM) induction, time-domain electromagnetic (TDEM), and/or ground penetrating radar (GPR) techniques may be conducted at selected sites. The objectives of each investigation and survey design will be discussed in detail in the site-specific attachments. The following sections describe the generalized geophysical survey procedures to be used including review of existing data, survey control, equipment calibration, data validation, data processing and interpretation, and file tracking procedures.

5.2 GEOPHYSICS EQUIPMENT

All geophysical surveys will be conducted using equipment appropriate for the specific survey objective. Generally, digital equipment will be used for all geophysical surveying. In certain instances, analog geophysical instruments may be used provided they are outfitted with a digital datalogger. Factors to be considered when selecting appropriate equipment include but are not limited to: survey objectives (resolution); anthropogenic and natural noise sources; logistics; operator experience; cost; and availability. Operation of all geophysical instruments shall be in accordance with the manufacturer's operating instructions.

5.2.1 Review of Site Conditions

All relevant site data will be reviewed prior to conducting any geophysical survey. The site-specific attachments will address this review. The review will include but not be limited to all existing site surface and subsurface information (e.g., aerial photographs, utility maps, boring logs, etc.). Also included in this review should be an evaluation of potential noise sources both natural and anthropogenic (e.g., overhead and subsurface utilities, fences, buildings, etc.). Any geophysical surveys that have been conducted at or near the site will also be reviewed and addressed in the site-specific attachments.

5.2.2 Site Walkover

A site walkover will be conducted prior to preparing the site-specific attachment. The site walkover will address survey logistics (ingress and egress), vegetation removal needs, natural or anthropogenic sources of noise not previously noted, and location survey requirements.

5.2.3 Location Control

Location surveys for geographic control of geophysical surveys will be conducted based on specific survey objectives. For some geophysical tasks, relative GPS measurements collected simultaneously with geophysical data is appropriate. In such an instance, location surveying may consist of only a few control points. Some geophysical surveys may require each data collection location to be uniquely established. A geophysical survey such as finding a buried utility where the results are delineated in the field by surveyor stake or paint, may not require any land surveying. All control points will be established using a licensed land surveyor.

5.2.4 Site Preparation

Prior to conducting the geophysical survey, site preparation may be required. Site preparation may include but is not limited to vegetation removal, removal of surface debris and establishing ingress and egress points.

5.2.5 Site-Specific SAP

A Site-Specific SAP will be prepared prior to any geophysical surveying. The Site-Specific SAP will address the following:

- survey objective
- expected geophysical signature
- findings of site review and walkover
- equipment selection and basis for selection
- geophysical data acquisition, processing, and interpretation
- location survey
- reporting

5.3 SOIL GAS SURVEY

Soil gas surveys are not anticipated in these investigations. If soil gas surveys are required for specific projects, the site-specific attachments will provide a detailed description of this activity including rationale for use.

5.4 GROUNDWATER

Groundwater investigations will be conducted at PBOW to acquire data regarding groundwater level, groundwater flow, and contamination in relation to known or suspected contaminated areas. These investigations may consist of installation and development of new monitoring wells and collection of groundwater samples from both new and existing wells. Specific information as to location of monitoring wells, sample quantity, and analytical protocols will be provided in the site-specific attachments.

5.4.1 Monitoring Well Installation

New monitoring wells will be installed as a part of the ongoing site investigations at PBOW. Shallow wells will be installed in the soil overburden above the soil/bedrock interface and deep bedrock wells will be installed below the soil/bedrock interface. Borings for shallow wells will be advanced using hollow-stem auger drilling methods or equivalent. Borings for the bedrock wells will be advanced using a CME 85 rig equipped with a 94 mm wire line coring system, or equivalent. The rationale for the well placement, as well as anticipated depths and screen depths, will be provided in the site-specific attachments.

For the shallow monitoring wells, samples will be collected continuously with a stainless-steel continuous core sampler during drilling to provide a detailed lithologic log. For the bedrock monitoring wells, continuous rock cores will be collected from the top of bedrock to total depth using a 94mm wire line coring system. Descriptions of cores will be recorded on a boring log and will be archived in core boxes.

A JE geologist will supervise the drilling of each borehole and will maintain a record of the drilling and soil conditions encountered. The geologist will maintain continuous, legible, and detailed drilling logs from examining drill cuttings, recording samples/cores, and noting first-encountered and static groundwater levels for each borehole. A drilling log will be completed for all boreholes (Figure 5-1). Daily field notes will be kept in a bound logbook and will include sufficient information to reconstruct the progress of drilling operations, problems encountered, well installation procedures, etc. After completion of database entry, all field forms and documents will be archived in the project files at the JE offices in Oak Ridge.

After completion of the borings, well installations will be performed in conformance with USACE engineer manual EM-1110-1-4000 (USACE, 1998) requirements and in accordance with State of Ohio, *Technical Guidance for Well Construction and Ground Water Protection*, 2000. Well materials will consist of 2-inch ID schedule 40 PVC flush thread casing and screen, unless specified differently in the site-specific attachments. Well screen slot sizes and filter pack material will be specified in the site-specific attachments, however a 0.010 slot size and 20/40 filter pack will generally be used for most wells. Boreholes for well installation will be a minimum of 4" in diameter larger than the casing diameter to allow for 2' of filter pack and annular material on all sides of the screen and casing. Centralizers will be used for wells deeper than 30 feet and will be spaced at 20 foot intervals. Centralizers will not be placed

closer than 10 feet above the screened interval. All well materials will be placed using cased hole methods. The well will be constructed by placing a 1-foot layer of sand in the borehole below the screen and bringing the filter pack to 3 to 5 feet above the top of screen. Screen lengths for the wells will be specified in the site-specific attachments and will be sized according to the thickness of the permeable zone, but generally no smaller than 5 feet. A 3 to 5 foot-thick bentonite pellet seal will be placed above the sand pack, depth permitting, and the remaining annular space between the top of the seal and the elevation of the local frost line (42 inches below ground surface, Sandusky City Engineering Office, 419-627-7829) will be grouted continuously using a side discharging tremmie pipe from the bottom up. The type of grout used will be a bentonite-cement slurry grout with about 5 percent bentonite powder and 95 percent Type 1 portland cement, mixed with 5 to 7 gallons of clean water. Bentonite pellets will then be placed from the frost line to the ground surface.

Bedrock wells will require the installation of a 6-inch ID steel surface casing extending from ground surface to a minimum of two feet below the soil/bedrock interface. The surface casing will be pressure grouted into the bedrock and allowed to cure overnight before proceeding with rock coring. The steel surface casing will also serve as the outer protective casing required for all surface completions as discussed below.

Surface protection for above ground completions will consist of a 6-inch-diameter steel surface casing extending approximately 5 feet into the ground (1 to 2 feet below the frost line), where possible, and approximately 2.5 feet above the ground (a maximum of 0.2 foot above the top of the polyvinyl chloride (PVC) well casing) with a lockable cap set into and surrounded by a concrete pad 4 feet square and approximately 4 inches thick. In the case of bedrock wells the surface casing will extend to 2.5 feet above ground surface and will serve as the protective casing. To prevent the well casing from frost heave damage, the concrete pad will be constructed as outlined below.

Initially, a pit 4 by 4 feet around the protective casing will be dug to a depth of about 1 foot and 4 inches. A 2-foot-long, 8- or 10-inch-diameter PVC pipe will then be placed temporarily around the 6-inch steel casing; the annulus between the 8- or 10-inch PVC casing and the 6-inch steel casing and that between the steel casing and the 2-inch riser will be filled with bentonite pellets. Bentonite will be hydrated up to 1 hour using distilled water to form a "bentonite plug." Then, a 1-foot-thick gravel base will be laid in the pit. After the 8- or 10-inch temporary PVC casing is removed, concrete will be poured on top of the gravel base. The pad will be sloped a minimum of 2 inches from the surface casing to the edge of the pad to provide positive drainage. Four 3-inch-diameter steel posts extending 3 feet above the pad will be driven 3 feet into the ground at equal spacing around the surface casing outside of the perimeter of the concrete pad. An internal drainage hole will be drilled through the steel casing just above the mortar collar. A permanent metal tag will be placed in the pad before curing or be affixed to the steel collar. The stamped metal tag will indicate the Nashville COE District, well identification, date of installation, and elevations of top and bottom of casing.

Surface completions for flush mount wells will be constructed with 48 inch well box skirting designed to extend to five feet bgs. The skirting will be placed inside of an 18-inch diameter sona-tube used as a form to encase the well box and skirting in cement. Prior to placing the sona-tube the well bore will be reamed to allow the sona-tube to extend to 5 feet bgs. Small diameter weep tubes will extend from the well box to the outside of the sona-tube prior to pouring the cement. The sona tube will be left in place and trimmed at the surface after curing. A permanent metal tag will be placed in the pad before curing, as with the above ground

completions.

Completed wells will be surveyed by a licensed land surveyor. A well installation diagram illustrating the depth of the boring, screen location, sand filter pack material, seals, grout, and height aboveground surface will be submitted to USACE, and will be included in the investigation report (Figure 5-2 and Figure 5-3). The well installation diagram and boring logs will also be filed with Ohio Department of Natural Resources.

Additional well installation instructions are included in JE Work Instruction WI-002, *Boring/Monitoring Well/Piezometer Installation.* Well locations and design criteria will be addressed in the site-specific attachments.

5.4.2 Monitoring Well Development

After each well has been constructed, but no sooner than 48 hours nor later than 7 days after the grouting and concrete apron have been placed, each well will be developed as required by the SOW. Wells will be developed by pumping or bailing without using acids, flocculants, disinfectants, or dispersing agents. All purged water will be drummed at the well site. Well development will be completed by pumping and surging. During development, the pump inlet will be moved through the entire screened interval. The development procedure will continue until the following conditions are met:

- water is clear to the unaided eye and free of sand.
- thickness of the accumulated sediment in the well is less than 5 percent of the length of the well screen
- temperature and pH stabilize at +/-1°C and +/- 0.2 respectively, ORP stabilizes at +/- 10mV, specific conductivity stabilizes at +/- 3%, and DO and turbidity stabilize at +/- 10% for three consecutive readings.
- volume of water purged is equal to five times standing water in the well including the well casing and screen, and the saturated annular space assuming 30 percent porosity has been removed.

Water shall not be added to the well once the well has been grouted and sealed. If after 6 hours of well development the groundwater is not clear and free of sediment, the USACE will be contacted for consultation and further instructions.

5.4.2.1 Well Redevelopment

If one of the following conditions are found to be exhibited at a well to be sampled, the well may be redeveloped according to the same procedures set forth in the previous section:

- Sediment accumulation in the well covers more than 5 percent of the total length of the well screen
- Turbidity of groundwater is greater than 20 Nephelometric Turbidity Units (NTU) after the well has been purged prior to sampling

- Recharge has declined through time; slow recharge is defined as a condition where upon removal of fluids from a well, the water level has not reached static level within 24 hours.

If after two episodes of redevelopment the well still does not meet the requirements, the well shall be deemed nonfunctional and may be scheduled for replacement or abandonment.

5.4.2.2 Development Records

The following records will be kept on a Well Development Log (Figure 5-4):

- Project name and location
- Well designation and location
- Date and time of well installation
- Date and time of well development
- Static water level from top of well casing before and 24 hours after well development
- Quantity of fluid in well prior to development:
  - Casing volume
  - Filter pack volume
- Field measurement of turbidity (NTU) twice during development
- Field measurement of pH, conductivity, and temperature before, twice during, and once after development
- Depth from top of well casing to bottom of well
- Screen length
- Depth from top of well casing to top of sediment inside well, before and after development
- Physical characteristics of removed water, including changes in clarity, color, particulate, and odor
- Type and size/capacity of pump used
- Description of surge technique
- Measured height of well casing above ground surface at time of development
- Typical pumping rate and estimated well yield
- Quantity of water/fluid removed during development, both incremental and total.
- Disposal of development water.

Additional well development instructions are included in JE Work Instruction *WI-046, Well Development.*

5.4.3 Water Level Monitoring

The depth to water will be measured periodically to assess seasonal changes and storm event fluctuations and for general groundwater parameters such as shallow and deep gradients and direction of flow. In addition, water levels will be collected prior to purging and sampling of all monitoring wells. Measurements will be collected to the nearest 0.01 foot from the survey mark on the riser from which the elevation has been surveyed, using a Solinst SOL1 Water Level Meter or equivalent. Water level measurements will be documented on the Monitor Well Static Water Level Form (Figure 5-5).

Additional water level measurement instructions are included in JE Work Instruction WI-006, *Static Water Level and Total Depth Measurement.* Investigation requirements for monitoring programs and objectives will be addressed in the site-specific attachments.

5.4.4 Groundwater Sampling

Groundwater samples will be collected from existing and newly installed monitoring wells. Proposed and existing groundwater monitoring well locations will be shown in the figures presented in the site-specific attachments. The analyses to be performed on samples collected from each of the wells will be identified in tables located in these attachments.

Groundwater sampling will be conducted starting with the areas assumed to be least contaminated to the areas assumed to be most contaminated. All sampling and purging equipment (pumps, tapes, and any reusable discharge hose) will be decontaminated before use and before each successive use in accordance with the decontamination procedures discussed in section 5.4.5. Collection of groundwater samples will be documented in the Monitor Well Purging Form (Figure 5-6) and Groundwater Sampling Field Data Form (Figure 5-7)

The groundwater sampling equipment will include the following:

- Water level indicator
- Low-flow submersible pump with Teflon®-lined tubing
- Pump Controller
- Portable Generator
- Flow-through cell equipped with dissolved oxygen, pH, temperature, turbidity, specific conductance, and oxidation/reduction potential.
- Appropriate sample bottles and temperature-controlled container
- Plastic sheeting
- 5-gallon buckets with lids
- Photoionization detector (PID)

Sampling of newly installed monitoring wells will take place no sooner than 14 days after well development has been completed. All equipment used to purge wells and collect samples will be protected from ground surface contact and contamination by use of clean plastic sheeting. The following procedures will be followed when collecting groundwater samples from all monitoring wells:

- The well will be checked for proper identification and structural integrity.
- After unlocking the well and removing the well cap, a PID will be used to measure the concentration or organic vapors at the top of casing and in the breathing zone. If readings are above background, safety precautions outlined in the SHP and SSHP will be followed.
- The depth to water will be measured using a decontaminated water level indicator, then the volume of water to be purged will be calculated. The purge volume will be based on 3 well screen volumes, which will include the saturated filter pack around the well screen.
- Where recharge rates permit, the well will be purged by an appropriate submersible sampling pump to remove three screen volumes. Low flow purging will be performed at a rate that allows for stabilization or gradually rising water levels, prior to, and during sampling. Efforts will be made to minimize the amount of drawdown while establishing the appropriate purge rate. Water levels will be monitored continuously during purging and sampling and will be recorded every 10 minutes along with the other water quality parameters.
- During purging and sampling, field measurements of pH, temperature, ORP, DO, turbidity, and conductivity will be performed every ten minutes utilizing an in-line flow-through cell. Sampling will not be performed until temperature and pH stabilize at +/-1°C and +/- 0.2 respectively, ORP stabilizes at +/- 10mV, specific conductivity stabilizes at +/- 3%, and DO and turbidity stabilize at +/- 10% for three consecutive readings.
- Groundwater samples will be collected using a submersible sampling pump and in-line sampling filters.
- Sample containers will be labeled with appropriate identifying information (location, date, time, condition, added preservatives, etc.). The preprinted labels will be provided by the field sampling crew leader. Each sample will be logged in a field notebook at the time of collection. Sample containers of appropriate volume and composition will be prepared in advance to ensure the collection of sufficient volumes for all specified analyses.
- The samples will be collected in the order of priority as VOC, SVOC, nitroaromatics, metals, and, lastly, other analytes as required for individual projects.
- Samples for volatile analysis will be collected in screw-cap, septum-top glass vials and filled so that there are no air bubbles present to allow volatilization.
- Samples for metals analysis will be collected in two separate containers; one will be filtered and the other will not be filtered. Samples will be filtered according to the following procedures:
- The water sample will be filtered at the well site utilizing in-line disposable filters with a 0.45-

micron filtering capacity or equivalent. Analysis for Mn II and Fe II will be performed in the field using a HACH or equivalent field test kit.

- All sample containers will be transferred to a cooler chest (kept at 4 degrees Celsius (°C)] and delivered to the laboratory in sufficient time so that specified holding times are not exceeded.

Additional groundwater sampling instructions are included in JE Work Instruction *WI-015, Groundwater Purging and Sampling.* Well locations and chemical analysis to be performed will be addressed in the site-specific attachments.

5.4.5 Field Hydraulic Conductivity Testing

Field hydraulic conductivity will be evaluated at newly installed wells at the PBOW by performing slug tests after well development. These wells will be specified in the site-specific attachments. To avoid altering the groundwater chemistry at the site by the introduction of water, water will be instantaneously removed (slug out) from each well to decrease the hydraulic head. The head recovery rate will be recorded, and these data will then be evaluated by the appropriate method to determine in situ hydraulic conductivity. Pressure transducers and electronic data loggers will be used to record water level changes in the well during the test. Test data will be downloaded to a laptop computer and evaluated in the field before departure from the site to ensure complete and usable data are collected. One test will be performed in each new well unless unusable data are obtained. Slug test data will be analyzed for aquifer parameters using the computer software AQTESOLV. Permeability testing procedures are described in detail in JE Work Instruction *WI-008, Slug Tests.* At a minimum the header information on the Slug Test Data Form (Figure 5-8) will be completed for each test conducted. Time and depth information will automatically be recorded on the data loggers. Additional information as necessary will be recorded in the field logbook.

Pump tests may be performed at select wells to more accurately determine hydraulic conductivity and other aquifer parameters, or to qualitatively or quantitatively evaluate connectivity between shallow and deep groundwater, and to assess potential contaminant migration and flow paths. Pump tests will be designed based on site-specific data and will be addressed in the site-specific attachments. Pump test procedures and instructions are included in JE Work Instruction *WI-009, Aquifer Pumping Tests.* At a minimum, the header information on the Aquifer Test Data Form (Figure 4-9) will be completed for each test conducted. Time and depth information will automatically be recorded on the data loggers. Additional information as necessary will be recorded in the field logbook.

5.4.6 Equipment Decontamination

Down hole pumps will be placed in a series of 5-gallon buckets containing potable water and alconox, followed by potable water only, and lastly American Society for Testing and Materials (ASTM) Type II reagent grade water. The pump will be allowed to run for several minutes in each solution to thoroughly clean and rinse all internal parts. Likewise, the lead line for all down hole pumps will be submersed and scrubbed in the same containers. These containers will be changed out with new solutions after every third decontamination. Water level indicators will likewise be cleaned in the same manner. Slugs used for aquifer tests, bladder pumps, and pressure transducers will be decontaminated in 6" diameter PVC pipes designed to hold decontamination fluids and to ensure complete immersion. Exteriors of these equipment items

will also be scrubbed with brushes.

5.5 SURFACE AND SUBSURFACE SOIL SAMPLING

Soil investigations will be conducted at PBOW to acquire information regarding subsurface lithology, nature and extent of contamination and risks to human health and the environment. Specific information as to location of soil borings, sample quantity, sample depths, and analytical protocols will be provided in the site-specific attachments.

5.5.1 Surface Soil Samples

Surface soil samples refer to the collection of native soil samples from above the 1-foot depth. Samples for non-VOC analysis will be collected with a PTFE spoon and PTFE or glass bowls and homogenized prior to sampling. Dedicated equipment will be used at each site thus eliminating the need for additional QC samples. The sample will then be placed in the appropriate container for laboratory analysis. VOC samples will be collected with an Encore sampler or equivalent. Additional procedures are provided in JE Work Instruction WI-021, *Soil Sampling*.

5.5.2 Subsurface Soil Samples

Soil borings will be advanced using direct push technology (DPT), hollow-stem auger with split-core samplers, or equivalent, depending on the needs of each project investigation. When collecting soil samples for chemical analysis, the core barrels or augers will be equipped with stainless steel sleeves. Soil borings will be logged in accordance with ASTM D-2488-93 using the USCS. Soil samples will be continuously collected from 6 inches below the surface to the total depth of the boring. All soil cores will be screened for the presence of organic vapors using an organic vapor analyzer (OVA), such as an HNu, and the soil will be visually classified. The depth interval and reading in units of ppm will be recorded for any portion of the sample where organic vapors are detected.

VOC samples will be collected from the stainless steel sleeve using an Encore or equivalent device. The remainder of the soil will be extruded from the stainless steel sleeves into a PTFE or glass bowl and will be homogenized using PTFE spoons. Non-VOC samples will be placed in the appropriate sample containers, labeled for proper identification, and packed in a cooler with ice pending the completion of the hole. Soil samples will be submitted for laboratory analysis based on the results of the field screening for organic vapors, visual evidence of contamination or alteration, predefined depth ranges for samples or other criteria as determined by the on-site geologist based on the conditions encountered. The criteria for sample selection will be documented in the field logbook.

The field geologist will maintain a detailed boring log (Figure 5-1) during the drilling of each borehole. The log will serve as a record of sample collection, sample location and depth, and drilling procedures.

All soil cuttings generated during the drilling of soil borings will be handled in accordance with the investigation-derived waste (IDW) management plan in Chapter 8.0. The minimum number of samples selected and the specific laboratory analyses to be performed for each site will be included in the site-specific attachments.

JE will obtain the necessary dig permits from NASA before any intrusive work is conducted.

5.5.3 Exploratory Trenching and Soil Sampling

Exploratory trenching will be conducted for various site investigations for the purpose of obtaining visual characterization of subsurface soil and buried materials and for collecting discreet soil samples from biased locations, to determine the extent of contamination. Trenching will be conducted with a rubber tire or track mounted backhoe. Soil samples will be collected directly from the backhoe bucket. VOC samples will be collected first with an Encore sampling device or equivalent from a section of soil that is least disturbed. Samples for non-VOC analysis will be collected with a PTFE spoon and PTFE or glass bowls and homogenized prior to sampling. Samples will then be transferred to individual sample containers.

Additional trenching procedures and sampling instructions are included in JE Work Instruction WI-050, *Test Pit Sampling*. Trench locations and chemical analysis to be performed will be addressed in the site-specific attachments.

JE will obtain the necessary dig permits from NASA before any intrusive work is conducted.

5.5.4 Soil Samples for Geotechnical Analyses

Selected soil samples may be collected for geotechnical analysis. At a minimum, all soil and sediment samples collected and submitted to the laboratory for chemical analysis will be tested for moisture content in accordance with (ASTM D2216). Other geotechnical analysis required will be addressed in the site-specific attachments.

5.5.5 Decontamination Procedures

Drilling and sampling equipment decontamination will be performed to maintain integrity of the environmental samples collected. A temporary decontamination pad will be built and used for drilling and excavation equipment. The station will be lined with three layers of at least 6-mil Visqueen®, and will be bermed on all sides. In addition to the berms, the decontamination pad will be constructed so that the drill rigs can be driven onto the Visqueen for decontamination and so that all decontamination water can be collected and placed in 55-gallon drums. Sampling and other portable equipment may be decontaminated at a fixed decontamination station. Specific procedures for equipment decontamination are provided in WI-036, *Equipment* All equipment that may directly or indirectly contact samples will be decontaminated in a designated decontamination area. This includes casing, drill bits, auger flights, the portions of drill rigs that stand above boreholes, sampling devices, and instruments such as slugs and sounders. In addition, the contractor shall take care to prevent the sample from coming into contact with potentially contaminating substances, such as tape, oil, engine exhaust, corroded surfaces, and dirt.

The following general procedure will be used to decontaminate large pieces of equipment, such as casings, auger flights, pipe and rods, and those portions of the drill rig that may stand directly over a boring or well location or that come into contact with casing, auger flights, pipe, or rods. The external surfaces of equipment will be washed with high-pressure hot water and Alconox, or equivalent laboratory-grade detergent, and, if necessary, scrubbed until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed. The equipment will then be rinsed with potable water. The inside surfaces of casing, drill rod, and auger flights

shall also be washed as described.

All equipment that may contact the interior of a hole or that may contact other equipment that will enter the hole (including, but not limited to, drill rods, bits, and tools) will be thoroughly cleaned at the decontamination pad by using steam or high pressure hot water from a steam-cleaner prior to setting up on the first hole, between each hole, and following drilling of the final hole. No tools or drilling equipment may contact the ground or become contaminated after cleaning until used in drilling. If this situation occurs, contaminated items will again be cleaned before use in the manner specified previously. At the drill site, cleaned equipment will be kept off the ground by storing on cleaned metal racks (not wooden pallets) or on polyethylene-covered pallets. The drilling rig will be cleaned between drilling each monitoring well and between mobilization from site to site.

Dedicated stainless steel bowls, spoons, and core sleeves will be used for the collection of all surface and subsurface soil samples and will be disposed after use, thus eliminating the need for equipment decontamination.

5.6 SEDIMENT SAMPLING

Sediment investigations will be conducted at PBOW to acquire information regarding impacts to sediments from adjacent AOCs, and associated risks to human health and the environment. Specific information as to location of samples, sample quantity, and analytical protocols will be provided in the site-specific attachments.

Sediment samples may be collected in association with surface water at co-located positions. When both surface water and sediment samples are to be collected, the surface water sample will be collected first according to JE Work Instruction WI-017, *Surface Water Sampling*. Sediment sampling usually results in disturbance of the sediments, which may influence the analytical results of the surface water samples.

When collecting sediment samples from multiple locations during a sampling event, sampling will be conducted from the most downstream point first and proceed upstream.

When collecting sediment samples for volatile organic analysis an Encore sampling device, or equivalent, will be used, if possible. If sediment samples cannot be collected directly from the stream using this method, a hand coring device equipped with stainless steel sleeves may be used. The VOC samples will then be collected from the sleeves using the Encore or equivalent. Samples for non-VOC analyses will be collected with a hand coring device equipped with stainless steel sleeves or collected directly from the stream using PTFE spoons and placed in a PTFE or glass bowl and homogenized prior to filling sample containers.

If the person collecting the sediment sample needs to enter the water in order to collect the sample, this should be done downstream of the actual sample location with care not to disturb the sediment in the location to be sampled.

Additional sediment sampling instructions are included in JE Work Instruction WI-022, *Sediment Sampling*. Sample locations and chemical analysis to be performed will be addressed in the site-specific attachments.

Dedicated stainless steel bowls, spoons, and core sleeves will be used for the collection of all sediment samples and will be disposed after use, thus eliminating the need for equipment

decontamination.

5.7 SURFACE WATER SAMPLING

Surface water investigations will be conducted at PBOW to acquire information regarding impacts to surface water bodies from adjacent AOCs, and associated risks to human health and the environment. Specific information as to location of samples, sample quantity, and analytical protocols will be provided in the site-specific attachments.

Surface water samples may be collected in association with sediment samples at co-located positions. Surface water samples will be collected in a manner that does not cause cross contamination. If collecting both water and sediment samples at a specific location, the surface water samples will be obtained first. Water quality parameters may be measured at each sampling location, to include pH, temperature, specific conductance, and dissolved oxygen (when required) at each surface water sampling point.

The sample collection sequence is as follows: (1) if sampling both water and sediment or just sediment, start at the most downstream point and proceed upstream, (2) if sampling water only and the sample can be taken without disturbing the river or stream bottom, obtain any background samples first, then the farthest downstream sample, and then move upstream toward the source or discharge point, (3) if sampling water only and the stream or river bottom must be disturbed, start at the most downstream point and proceed upstream,

Samples will be taken from the active portion of the stream on the side nearest the source of contamination or suspected discharge. Sampling will be conducted in a manner that does not disturb sediment or cause the sediment to be suspended and incorporated into the water sample. In cases where the sampling technicians must enter the water body to obtain the samples, the technician will enter downstream of the sampling point and collect the samples from the upstream direction. If the water body does not have sufficient flow to move disturbed and suspended sediment downstream of the sampling point a peristaltic pump will be used as discussed below.

When the surface water body is deep enough, non-VOC water samples will be collected as grab samples using the sample container. If the depth of water does not allow for direct fill methods, if the sample container has been prepared with preservative, or if the potential exists for disturbing and suspending sediment, a peristaltic pump, utilizing disposable tubing shall be used to obtain undisturbed water samples. A rod may be required to extend the intake line to the appropriate sampling point. The intake line will be attached to the rod and will be extended several inches beyond the end of the rod to ensure there is no contact of the rod with the surface water.

For VOC analysis, the sample will be partially filled by direct fill methods or from the peristaltic pump. If direct filling the final amount needed to form a meniscus should be collected with the vial lid and transferred to the sample vial using a slow, controlled pour. The sample vial will be filled until a positive or convex (bulging) meniscus is visible and immediately sealed. When the bottle is capped, it shall be inverted and gently tapped to ensure no air bubbles are present in the vial. If bubbles are present after the initial filling, the vials will be discarded as investigative derived waste and the VOC sampling effort will be repeated. After the containers are sealed, sample degassing may cause bubbles to form. These bubbles will be left in the container. These samples will never be composited, homogenized, or filtered. If the potential exists for

disturbance of the water with suspended sediment during the collection of VOC samples, non-VOC samples will be collected first utilizing nondisturbing methods and the VOC samples will be collected last.

The pH of preserved samples will be checked in the field by pouring a small amount of the water sample onto pH paper. The paper will not touch the sample inside the container. Do not check the pH of acidified VOC samples. The preservation checks shall be documented in the COC forms. One preserved VOC sample per day per sampling crew will be checked with pH paper. The sole purpose of this sample is to check the pH of VOC samples; it will not be submitted for analysis.

Following collection of VOC samples, remaining water samples will be collected in the following order: SVOCs, including PAHs; pesticides; PCBs; metals; mercury; cyanide; total organic carbon; anions/cations; and dissolved oxygen.

The following records will be maintained in addition to those in Section 6.0: (1) the width, depth, and flow rate of streams, (2) surface water conditions (e.g., floating oil or debris, gassing), (3) the location of any discharge pipes, sewers, or tributaries, and (4) instrument calibration.

Additional surface water sampling instructions are included in JE Work Instruction WI-017, *Surface Water Sampling*. Sample locations and chemical analysis to be performed will be addressed in the site-specific attachments.

Direct fill methods will be used or dedicated disposable tubing will be used, thus eliminating the need for decontamination.

5.8 OTHER MATRICES

No other matrices other than those described in Sections 4.3 and 4.6 are anticipated to be sampled during the PBOW investigations.

5.9 LAND SURVEYING

Generally, land survey requirements for the investigations at PBOW will include the following:

- Establish grid corners of geophysical survey locations.
- Locate soil boring and monitoring wells sampling positions.
- Locate and establish elevation of installed monitoring wells and actual drilling sites of soil borings.

All elevations will be referenced to the 1988 North American Vertical Datum (NAVD). All horizontal coordinates will be referenced to the State Plane Coordinate Systems (SPCS). Elevation and coordinates will be surveyed to the closest 0.1 foot. Additional surveying procedures are contained in JE Work Instruction WI-003, *Land Surveying*.

5.9.1 Control Monuments

Existing permanent control monuments will be used for each site. Adequate control is present at the facility.

5.9.2 Monitoring Wells

Horizontal coordinates for all new monitoring wells will be measured to the nearest 1.0 foot and referenced to the SPCS. Elevations will be measured at the top of the well casing to the nearest 0.01 foot. All elevation measurements will be referenced to the 1988 NAVD. The measurement point on the top of the well casing will be clearly and permanently marked for future water level measurements. The unique monitoring well identification number will be permanently marked on the protective cover.

5.9.3 Geophysical Survey Grids

Geophysical survey grids will be surveyed at each of the four boundary corners. Grids within the survey boundary will not be surveyed. Survey of geophysical grids will be conducted concurrently with other land survey activities in order to locate the geophysical survey areas on the site map. Land surveying prior to a geophysical survey will not be required.

5.9.4 Soil Boring Locations

Each soil screening sampling location and soil boring will be established in the field by the site geologist/coordinator. Each location, once sampled, will be clearly marked with a stake, pin, or similar item until it can be surveyed. The sample location identifier will be written in waterproof ink on each marker.

Soil boring locations (samples below the 1-foot depth), once grouted and properly marked, will be surveyed for horizontal coordinates to the nearest 0.1 foot and referenced to the SPCS. Surface elevations of soil borings will be measured to the nearest 0.1 foot referenced to the 1988 NAVD.

5.9.5 Surface Water and Sediment Locations

Surface water and sediment sampling locations will be marked with a stake driven in the bank adjacent to the sampling location, which will be labeled appropriately. Each sampling location will be surveyed from the edge of the water adjacent to the stake and elevation data will coincide with the surface of the water body.

6.0 FIELD OPERATIONS DOCUMENTATION

6.1 FIELD LOGBOOK AND SAMPLE FORMS

Field records will be maintained to provide sufficient information to recreate all sampling and measurement activities and to meet all final reporting and data management requirements. The requirements listed in this section apply to all measuring and sampling activities. Requirements specific to individual activities are listed in the section that addresses each activity. The information will be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records will be archived in an easily accessible form and made available upon request.

The following information will be recorded for all field activities: location, date and time, identity of people performing the activity, and weather conditions. For field measurements, the numerical value and units of each measurement, and the identity of and calibration results for each field instrument shall also be recorded.

The following additional information will be recorded for all sampling activities: sample type and sampling method, the identity of each sample and depth(s), where applicable, from which it was collected, the amount of each sample, sample description (e.g., color, odor, clarity), identification of sampling devices, and identification of conditions that might affect sample representativeness (e.g., refueling operations, damaged casing).

Records shall be kept in the form of logs and standardized forms. The logs and standardized forms typically used on the site are listed below.

- Field log notebook
- Utility Clearance Form
- Time and materials log
- Soil boring log
- Standard detail for monitor construction/installation
- Well development/purging log
- Calibration data form
- Water sampling form
- Request for analysis/COC form
- Field modification report
- Soil sample PID reading data sheet
- Slug test data field sheet

- Aquifer test data field sheet
- Site drum inventory
- Visitor log

All log sheets will be kept in the project files. Project files will be turned over to the USACE at the completion of the project contract. Entries on the logs will contain a variety of information. Specifically, this information will include:

- Project identification
- Field activity subject
- General work activity
- Unusual events
- Visitors on site
- Subcontractor progress or problems
- Communication with the client or others
- Weather condition
- JE personnel on site
- Sample number and time of day for each sample collected for analysis
- Listing by sample number of samples collected during the day, sorted by COC number (compiled at the end of the day); cross-reference between QA/QC samples and field samples
- Record of telephone call informing the laboratory of sample shipment
- Accomplishment of drilling equipment and sampling equipment decontamination
- Accomplishment of required calibration checks
- Disposition of decontamination fluids
- Variances from project plans and procedures (details will be recorded in the variance log)
- Accomplishment of tailgate safety meetings
- Review of project procedures with site personnel
- Photographs taken and identification numbers
- Air monitoring readings, as appropriate.

Additional instructions on field documentation are provided in JE Work Instruction WI-035, *Field Activity Records.*

6.2 PHOTOGRAPHIC RECORDS

Digital color photographs will be taken of various field activities and sampling events including well installation, well development, and soil and groundwater sampling activities. The photograph number will be recorded in the logbook to identify which sampling site is depicted in the photograph. A final photographic log will be produced to include the project number, date taken, and a brief description. Electronic records will be kept in project central files.

6.3 SAMPLE DOCUMENTATION

6.3.1 Sample Numbering System

The sample numbering system to be used during all investigations will conform to USACE-Nashville District's numbering convention. Specifically, each sample will be assigned a unique sample identification number that describes where the sample was collected. Each number consists of a group of letters and numbers, separated by hyphens. The sample media and numbering system is described as follows.

Project Code	Year	Sample Type	Site Identification	Location	Sample Round/ QA/QC Type	Depth
PBOW	04	XX	XXX	XXXX	XXXX	(XXXX)

Sample type:

SO - soil sample
GW - groundwater sample
FD - field duplicate
MS - matrix spike
MD - matrix spike duplicate
SS - soil screening sample
FB - field blank
FS - field split
ER - equipment rinsate

Site Identification:

TNTA - TNT Area A
TNTB - TNT Area B
TNTC - TNT Area C
PH2 - Powerhouse No.2 Ash Pit
2BG - Reservoir No.2 Burning Ground
ABG - Additional Burning Ground
WP2 - Waste Water Disposal Plant No.
WARWP - West Area Red Water Pond

Location/Round: Unique identifier for each sample location or station followed by a numerical indication of the sampling round.

Sample QA/QC Type: – A – Primary sample – B – QA sample – C – Field equipment blank sample – D – Field QC duplicate sample – E – Trip blank sample Depth: only required for soil samples.

PBOW-96-S0-ABG-0003-0129-(0'-0.5') signifies that this soil sample is collected at a depth between 0 and 0.5 foot below ground surface (bgs) from soil boring 0003 with a laboratory number 0129 at Additional Burning Ground site at PBOW. "PBOW-96-GW-TNTC-BEDMW13-0235" indicates that this groundwater sample is collected from monitoring well BED-MW13 in TNT Area C with a laboratory number 0235. The complete sample number will be recorded by the JE field geologist or sampler in the field logbooks, in the Boring Log, or in the Sample Collection Log as appropriate.

6.3.2 Sample Labels

All physical samples for laboratory analysis obtained at the sites will be placed in an appropriate sample container for shipment to the laboratory. Sample labels are to be completed for each container using waterproof ink unless inhibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample label because the ballpoint pen would not function in freezing weather. Refer to Figure 6-2 for an example sample label. The following information will be included on the label:

- Project identification
- Sample identification
- Sample location
- Date of collection
- Time of collection
- Required analytical methods
- Sampler's initial.

6.3.3 Chain-of-Custody Records

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

The contractor will maintain COC records (Figure 6-1) for all field and field QC samples. A sample is defined as being under a person's custody if any of the following conditions exist: it is in their possession, it is in their view, after being in their possession, it was in their possession and they locked it up, or it is in a designated secure area.

The following minimum information concerning the sample will be documented on the COC form:

- Source of sample (including name, location, and sample type)
- Designation of MS/MSD
- Preservative used
- Analyses required
- Name of collector(s)
- Unique sample identification
- Date and time of sample collection
- Pertinent field data (pH, temperature, etc.)
- Custody transfer signatures, and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

All samples will be uniquely identified, labeled, and documented in the field at the time of collection.

Field custody procedural activity includes:

- The field team member collecting the sample will have overall responsibility for the care and custody of the samples collected until they are transferred or properly dispatched to the laboratory. Each individual who collects a sample will be considered responsible for sample custody until transferred to someone else via the chain of custody (COC).
- COC records initiated in the field will be placed in a plastic bag and placed on top of the samples in the shipping container used for sample transport from the field to the laboratory.
- Shipping containers will be secured using strapping tape and custody seals to ensure that samples have not been disturbed during transport. The custody seals will be placed on each container so that they cannot be opened without breaking the seal.
- Shipment information will be recorded for shipment of samples at the end of the shift, day, or collection period in the field logbook.

Transfer of custody and shipping procedures include:

- A COC will be initiated in the field for each sample or group of samples. A copy of this record will accompany each sample shipment.
- The custody of individual sample containers will be documented by recording each container's identification on an appropriate COC.

- Each time responsibility for custody of the sample changes, the new custodian will sign the COC and note the date.
- The analyses to be performed for each sample will be recorded on a COC.
- The air bill number will be recorded on the COC when a commercial carrier is used.
- If the laboratory sample custodian judges sample custody to be invalid (e.g., samples arrive damaged or custody seals have been broken), a nonconformance report will be initiated. The JE Project Chemist will be advised immediately and the samples will not be analyzed unless the JE Project Chemist or PM so authorizes. The sample(s) will either be processed "as is" with custody failure noted along with the analytical data, or rejected with sampling rescheduled if necessary.

Refer to Section 4.1 of the QAPP for sample receipt procedures to be followed by the off-site laboratories.

6.4 FIELD ANALYTICAL RECORDS

A sample logbook will be used by the JE field geologist or sample technician to keep track of sample collection, designation, and packing and shipping information for all samples. Upon completion of the fieldwork, the sample logbook will be kept in the project files for future reference.

6.5 DOCUMENTATION PROCEDURES / DATA MANAGEMENT AND RETENTION

Refer to Section 8.0 of the QAPP for data management procedures and Section 7.5 of the QAPP for archival procedures.

7.0 SAMPLE PERSERVATION, PACKING, AND SHIPPING

Samples will be collected in appropriate containers and preserved according to the procedures summarized in the site-specific attachments to the QAPP. Each sample container will be bagged before placement in the cooler. Sample holding times will be calculated from the date the sample is collected, not the date that it is received by the laboratory. Unless prior arrangements are made, the sample containers will be shipped to the site with necessary preservatives added.

Samples for geotechnical analysis need not be chemically preserved; however, the samples will be properly sealed to prevent moisture loss and will be packaged so that the material is adequately preserved in its natural state.

Samples will be placed in coolers as soon as possible after collection and will be packaged so as to minimize the possibility of container breakage by using bubble-wrap, vermiculite, or Styrofoam™ peanuts to fill void spaces in the cooler. Samples will be cooled as promptly as feasible to a temperature of approximately 4°C and maintained at that temperature by means of ice from the time the shipping carton is sealed using tape and custody tape until it is received at the laboratory. Coolers will be shipped to the laboratory by a next-day delivery service. Notification of shipment, including air bill number, will be telephoned.

8.0 INVESTIGATION DERIVED WASTE MANAGEMENT PLAN

The following sections describe procedures for the handling, temporary storage, and disposal of IDW. IDW materials include cuttings from soil borings and monitoring well installations; decontamination fluids; purge water, soil, and other materials from the collection of samples; and disposable or contaminated personal protective equipment (PPE).

IDW shall be segregated at the site according to matrix (solid or liquid) and how the IDW was derived (drill cuttings, drilling fluid, decontamination fluids, and purged groundwater). Each container shall be properly labeled with site identification, sampling point, depth, matrix, constituents of concern, and other pertinent information for handling. Information pertaining to IDW will recorded on the Waste Inventory Tracking Form (Figure 8-1).

8.1 MINIMIZATION OF INVESTIGATION-DERIVED WASTE

Advance planning should be used to minimize the quantities of IDW generated. Boring sizes will be as small as possible to accomplish the task. Excess soil and sediment from hand auguring and similar applications at shallow borings and surface sampling locations will be returned immediately to the location from which it was obtained. When this procedure is not possible, soil should be containerized and stored until disposal. The IDW is not suspected to pose any immediate threat to human health or the environment.

8.2 DRILLING CUTTINGS FROM BORINGS

Drill cuttings are generated from borings for subsurface soil sample collection and from borings for monitoring well installations. Drill cuttings from all borings will be collected and placed in 55-gal. drums and will remain segregated by location until analytical data from borehole samples have been received. Following receipt of the analytical data soil waste will be consolidated into two categories; one containing soil with no contamination above RBCs and the other with sample results that exceed the RBC's. Waste characterization samples will then be collected from each drum and submitted to an off-site laboratory and tested for full toxicity characteristic leaching procedures, except for herbicides and pesticides, and for ignitability, corrosivity, and reactivity, for determination of disposal method. All soil and cuttings will be transported by a specialty subcontractor and disposed at an approved off-site facility as either non-hazardous or hazardous waste, pending the results of the characterization samples.

8.3 PURGED GROUNDWATER

Water generated from well development and purging activities will be collected and containerized from each individual well. The volume of development water and purge water will be measured and documented. The containers will be clearly labeled as to the contents, the location at which the aqueous liquids were generated, and the date collected. The analytical results for samples collected from each well will serve as the basis for classification of the purged groundwater generated. All purge water will be transported by a specialty subcontractor and disposed at an approved off-site treatment facility.

8.4 DECONTAMINATION FLUIDS

Decontamination fluids, wash water containing nonphosphate soaps and rinse water, will be collected and containerized, transported by a specialty subcontractor and disposed at an approved off-site facility.

Decontamination fluids, used in the final rinse of sampling equipment and containing solvents such as methanol and hexane, will be collected and segregated from other decontamination fluids. Because of the small quantity generated, these fluids will be collected in metal pans for evaporation.

8.5 PERSONAL PROTECTIVE EQUIPMENT/DISPOSABLE EQUIPMENT

PPE includes all gloves, Tyvek suits, and other disposable equipment that cannot be adequately decontaminated to permit safe re-use. This material will be collected in double plastic-bagged liners and disposed in an approved industrial waste bin for subsequent disposal.

8.6 FIELD SCREENING LABORATORY WASTE

Laboratory wastes, generated from field screening of chemicals of concern in soils, will be collected and containerized for subsequent disposal at an approved off-site facility.

8.7 TEMPORARY STORAGE OF IDW

IDW will be stored temporarily in an area designated by the PBOW facility. Drums will be staged on pallets and covered with a tarp. The staging area will have a plastic sheeting floor with built up sides so as to prevent the release to the environment any drum contents in the event of a drum failure or spill. IDW will be disposed at an approved off-site facility within 3 months of collection.

9.0 FIELD ASSESSMENT/INSPECTION PROCEDURES

9.1 QUALITY CONTROL

To maintain quality during all fieldwork, a Contractor Quality Control process will be followed. The Site Manager may at times serve as the Quality Control (QC) Manager and be responsible for the implementation of this process. This representative will summarize the activities of each field activity task in Daily Quality Control Reports (QCR) (Figure 9-1). During all field activities, QCRs will be prepared, dated and signed by the Site QC Manager and submitted to the USACE Nashville District representative.

The following elements will be included in the QCR:

- Date
- General weather information
- Field instrument measurements and calibrations
- Departures from approved work plans
- Specific instructions from the Nashville District representative not in the work plans
- Problems or difficulties in the conduct of work
- Summary of samples collected, with corresponding QC/QA type samples noted

Attached to the QCR summaries will be copies of COC forms, field generated analytical results, and any other project forms that are generated during the period covered by the QCR summary.

The Site QC Manager will be responsible for ensuring the execution of the field activities complies with the approved SAPA and will report to JE QA/QC Manager and the Project Manager.

The QC Manager will monitor field activities to ensure, among other things, that field instruments are being properly used and calibrated; proper sampling procedures are being followed, and that QA/QC samples are being collected according to the approved protocols and frequencies.

All work at the PBOW will use the three-phase control process, Engineer Regulation (ER) 1180-1-6 and Corps of Engineers Guide Specifications (CEGS) 01450 and 01451. Contractor quality control (CQC) phases (preparatory, initial, and follow-up) will be performed onsite by a contractor-assigned QC officer whether or not a Government representative is present. The contractor will summarize the activities of each CQC phase in the daily QC Report. The CQC phases will be performed for each definable feature of work. For investigations at PBOW these features will include soil investigations, groundwater investigations, surface water and sediment investigations, and IDW management. The site-specific attachments will include identification of the CQC representative, descriptions of activities and definable features of work, and sample tables that will match up primary and QA samples required for the project

9.2 SAMPLING APPARATUS AND FIELD INSTRUMENTATION

Field equipment used for non-analytical measurements, including groundwater quality, air monitoring, and water level measurements will be calibrated and maintained according to the manufacturers operating manual.

Water quality meters will be used to measure conductivity, pH, salinity, turbidity, oxidation/reduction potential (ORP), and dissolved oxygen of groundwater and surface water samples collected at PBOW. The water quality meters will be calibrated daily with an auto-calibration solution and a pH 7 buffer solution per the manufacturers operating manual. The sensors and probes will be cleaned daily according to the manufacturers operating manual. Air monitoring equipment calibration and maintenance is addressed in Section 8.1.2 of the SHP. Calibration and maintenance records will be maintained at the site.

Field sampling equipment to be used for investigations at PBOW will be addressed in the site-specific attachments. The equipment lists will include field sampling apparatus and supplies, H&S monitoring equipment and supplies, decontamination equipment and supplies, sample preparation equipment and supplies, and various miscellaneous equipment.

10.0 VARIANCES NONCONFORMANCES AND CORRECTIVE ACTION PROCEDURES

10.1 VARIANCES

Changes (variances) to this plan including site-specific attachments may be initiated either in the field or in the office as may be necessary. All variances will be noted in the field logbooks and will be recorded on a Variance Log (Figure 10-1). Variances will be approved by the Quality Assurance Officer (QAO), PM, and USACE – Nashville District prior to implementation of the change. Variances that affect the project scope, cost, or schedule must be approved by USACE before being implemented.

10.2 NONCONFORMANCE AND CORRECTIVE ACTION PROCEDURES

Nonconforming equipment, items, activities, conditions, and unusual incidents that could affect compliance with project requirements will be identified, controlled, and reported in a timely manner. A nonconformance is defined as a malfunction, failure, deficiency, or deviation that renders the quality of an item unacceptable or indeterminate. A Nonconformance Log (Figure 10-2) will be maintained to track all Nonconformance Reports (Figure 10-3). The originator (any JE employee) of a Nonconformance Report will describe the finding on the form provided for this purpose and will notify the PM and QAO. Each nonconformance will be reviewed and a disposition given for the item, activity, or condition. The disposition of a nonconformance will be documented and approved by the JE organization responsible for the issuance of the nonconformance. The QAO will concur with the disposition of the nonconformance.

The laboratory coordinator is responsible for assessment of QC sample information. If data fall outside accepted limits, the QA/QC coordinator will immediately notify the laboratory PM and the responsible group leader. If the situation is not corrected and an out-of-control condition occurs or is expected to occur, the QAO will notify the PM. The PM and group leaders are responsible for identifying the source of the nonconformance and initiating corrective action. Completion of corrective action should be evidenced by data returning to prescribed acceptable limits. The procedures for laboratory nonconformances are discussed in more detail in the QAPP.

The modification, repair, rework, or replacement of nonconforming equipment, items, or activities will require the reverification of acceptability. In certain instances, as determined by the PM or QAO, these actions may require that corrective action be completed and verified before site work continues.

The equipment, item, or activity that has the deficiency may be temporarily stopped while the nonconformance is being investigated. If, in the opinion of the PM and the QAO, the nonconformance does not significantly affect the technical quality or use of the work, the work may continue pending resolution of the nonconformance. The basis for such decisions will be documented on the Nonconformance Report and submitted to the QAO for review and approval. The documentation will state that the decision was made prior to continuing with the work. The records of nonconformance and their dispositions will be kept in the project central files.

In addition, the PM will notify the USACE PM within 48 hours of significant nonconformances that could impact the schedule or the SOW and will indicate the corrective action taken or planned.

Additional procedures and instructions for handling nonconformances are addressed in JE Work Instructions *WI-054, Nonconformances and Corrective Actions.*

11.0 REFERENCES

Dames & Moore, 1996, *Site-Wide Groundwater Investigation Draft Report, Plum Brook Ordnance Works, Sandusky, Ohio*, May 1996.

Dames & Moore, 1995, *Records Review Report, Plum Brook Ordnance Works, Sandusky, Ohio*, April 27, 1995.

H^+GCL, 1992, *Phase I Site Characterization of Disposal Area Three, Plum Brook Station, Ohio*, June 1992.

IT Corporation (IT), 1991, *Engineering Report for the Contamination Evaluation at the Former Plum Brook Ordnance Works, Sandusky, Ohio*, January 1991.

IT Corporation (IT), 1997, *Site Investigations of the Reservoir No. 2 Burning Ground, Additional Burning Ground, Waste Disposal Plant No. 2, and Power House No.2 Ash Pit, Former Plumbrook Ordnance Works, Sandusky, Ohio*, December 1997.

Morrison Knudsen Corporation, 1994, *Site Inspection Report, Plum Brook Station, Sandusky, Ohio*, January 1994.

Shaw Environmental, Inc., 2003, *2002 Groundwater Data Summary and Evaluation Report, Former Plumbrook Ordnance Works*, June 2003.

State of Ohio, Administrative Code 37-45-300-10, *Groundwater Classification and Response Requirements (Proposed Rule)*, date unknown.

State of Ohio, *Technical Guidance for Well Construction and Ground Water Protection*, 2000

U.S. Army Corps of Engineers (USACE), 1998, Engineer Manual (EM) 1100-1-4000, *Monitoring Well Design, Installation and Documentation at Hazardous and/or Toxic Waste Sites*, November 1998.

U.S. Army Corps of Engineers (USACE), 1995, *Engineer Regulation (ER) 1180-1-6, Construction Quality Management*, September 1995.

U.S. Army Corps of Engineers (USACE), 1997, *Guide Specification 01450, Chemical Data Quality Control*, October, 1997

U.S. Army Corps of Engineers (USACE), 2003, *Guide Specification 01451, Contractor Quality Control*, January, 2003

U.S. Department of Agriculture (USDA), 1971, *Soil Survey, Erie County, Ohio*, Soil Conservation Service, February 1971.

U.S. Environmental Protection Agency (EPA), 2002, *Drinking Water Standards and Health Advisories*, Office of Water, Washington, DC, Summer 2002.

U.S. Environmental Protection Agency (EPA), 2003, *Risk-Based Concentration Table, July-December 1995*, Jennifer Hubbard, EPA Region III, April 16, 2003.

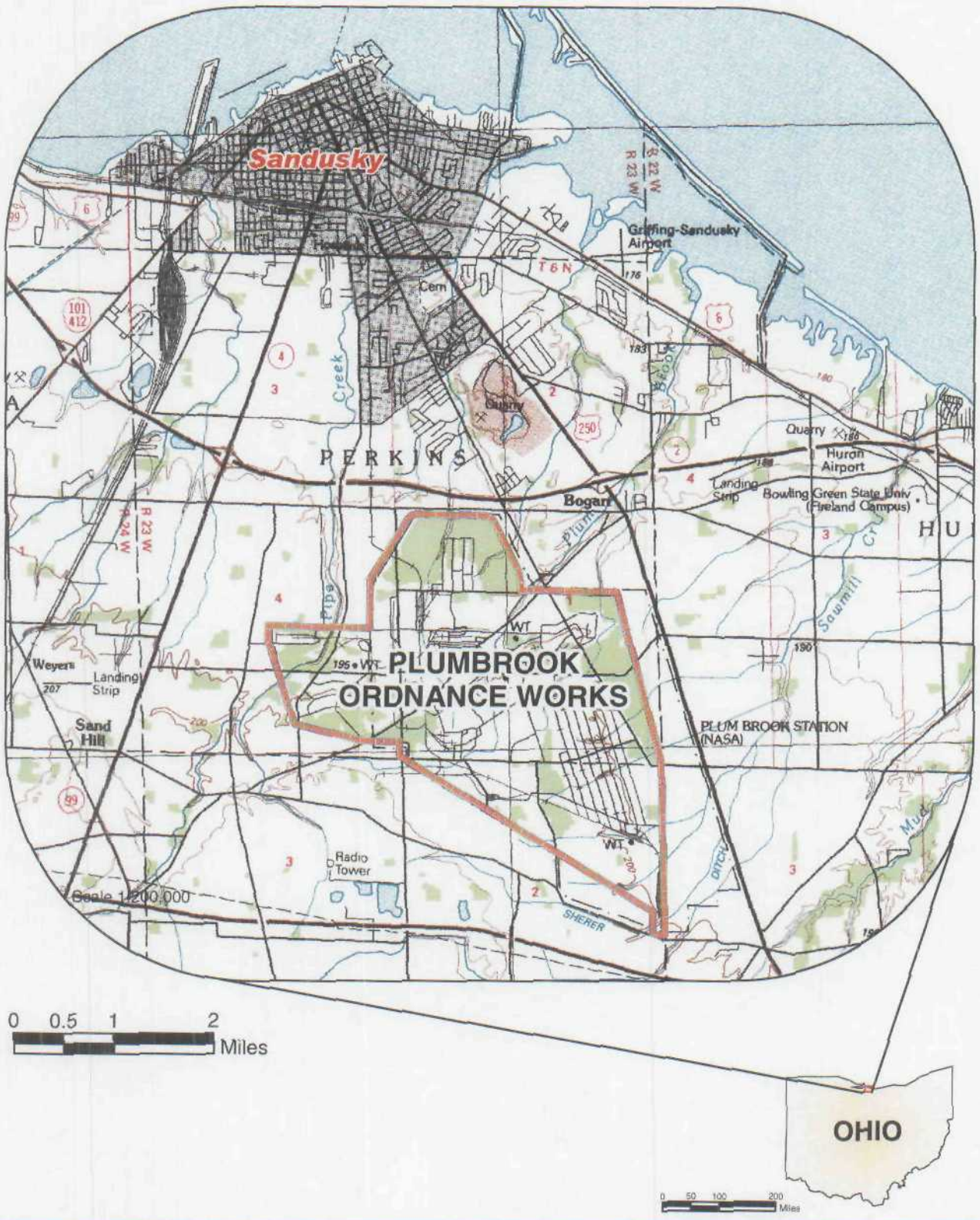
U.S. Environmental Protection Agency (EPA), 1994, *Guidance for the Data Quality Objectives Process (EPA QA/G-4), 1994*

U.S. Environmental Protection Agency (EPA), 2000, *Data Quality Objectives Process for Hazardous Waste Site Investigations* (EPA QA/G-4HW), 2000

U.S. Environmental Protection Agency (EPA), 1990, *National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule, Federal Register*, 55(4b):8666-8865.

U. S. Geological Survey (USGS), 1992, *Hydraulic Properties of Three Types of Glacial Deposits in Ohio*, Water-Resources Investigation Report 92-4135.

FSP Figures



Legend

Plumbrook Ordnance Works Boundary

N

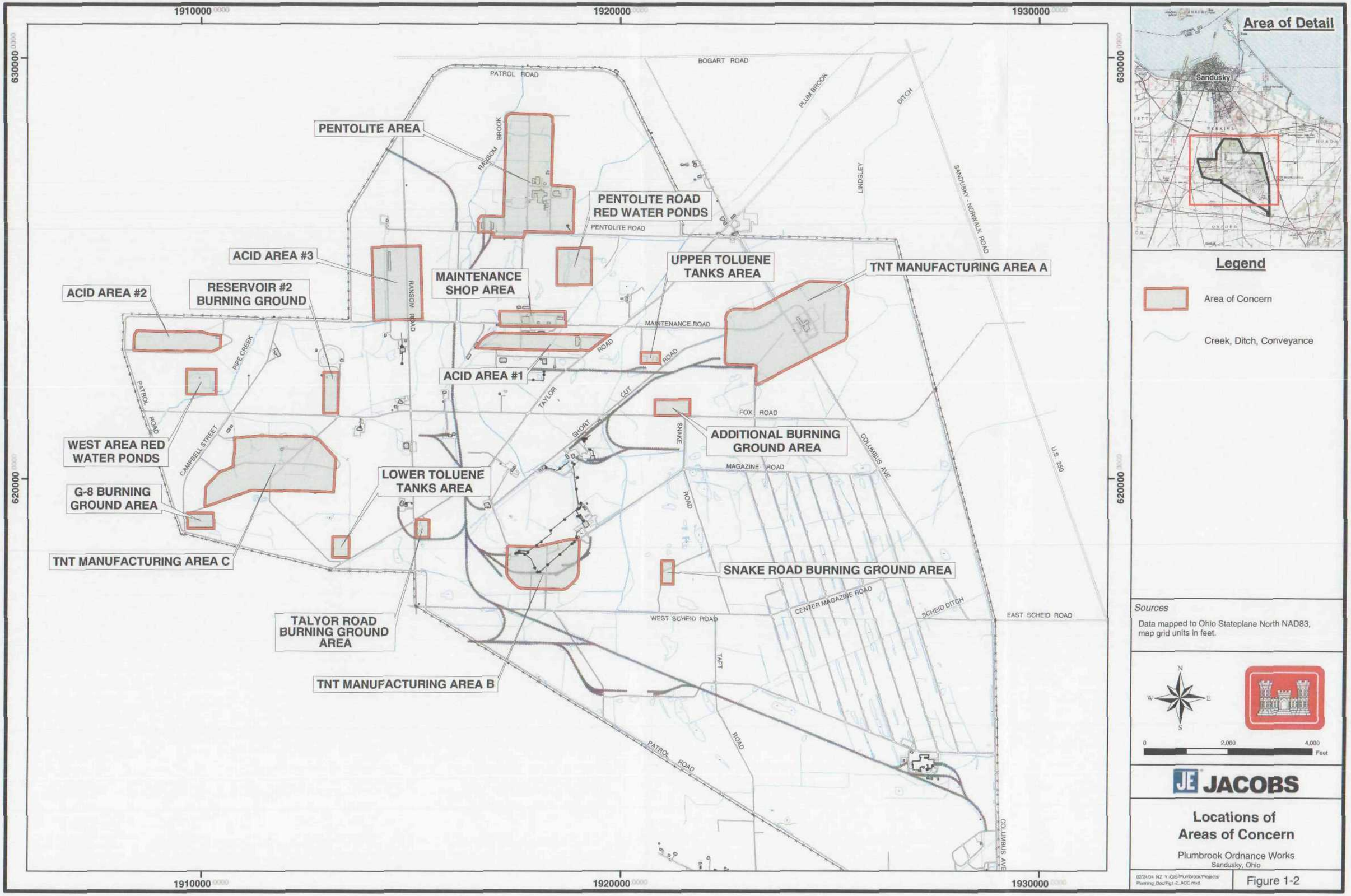
JACOBS

Location Map,
Plumbrook Ordnance Works
Sandusky, Ohio

Plumbrook Ordnance Works
Sandusky, Ohio

02/23/04 NZ Y:/GIS/Plumbrook/Projects/Planning_Doc/Fig1-1_Location.mxd

Figure 1-1


1910000
1920000
1930000
630000
620000
PENTOLITE AREA
PENTOLITE ROAD RED WATER PONDS
ACID AREA #3
ACID AREA #2
RESERVOIR #2 BURNING GROUND
MAINTENANCE SHOP AREA
UPPER TOLUENE TANKS AREA
TNT MANUFACTURING AREA A
ACID AREA #1
WEST AREA RED WATER PONDS
G-8 BURNING GROUND AREA
LOWER TOLUENE TANKS AREA
ADDITIONAL BURNING GROUND AREA
TNT MANUFACTURING AREA C
SNAKE ROAD BURNING GROUND AREA
TALYOR ROAD BURNING GROUND AREA
TNT MANUFACTURING AREA B
BOGART ROAD
PATROL ROAD
PENTOLITE ROAD
MAINTENANCE ROAD
FOX ROAD
MAGAZINE ROAD
CENTER MAGAZINE ROAD
WEST SCHEID ROAD
EAST SCHEID ROAD
SCHEID DITCH
RANSOM BROOK
RANSOM ROAD
PIPE CREEK
CAMPBELL STREET
TAYLOR
SHORT CUT
SNAKE ROAD
TAFT ROAD
COLUMBUS AVE
SANDUSKY - NORWALK ROAD
U.S. 250
LINDSLEY DITCH
PLUM BROOK
Area of Detail
Sandusky
Legend
Area of Concern
Creek, Ditch, Conveyance
Sources
Data mapped to Ohio Stateplane North NAD83, map grid units in feet.
N
W
E
S
0
2,000
4,000
Feet
JACOBS
Locations of Areas of Concern
Plumbrook Ordnance Works
Sandusky, Ohio
Figure 1-2

HTRW DRILLING LOG	DISTRICT	HOLE NUMBER
1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET OF SHEETS

3. PROJECT	4. LOCATION
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION
	9. SURFACE ELEVATION
	10. DATE STARTED / 11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

LOCATION SKETCH/COMMENTS SCALE:

PROJECT	HOLE NO.

Figure 5-1

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER		
PROJECT	INSPECTOR	SHEET OF SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	SAMPLE NO. OR CORE RUN NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)

PROJECT	HOLE NO.

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

Figure 5-1 (continued)

WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

FIELD REPRESENTATIVE: _____

DRILLING CONTRACTOR: _____

DRILLING TECHNIQUE: _____
AUGER SIZE AND TYPE: _____

BOREHOLE IDENTIFICATION: _____
BOREHOLE DIAMETER: _____
WELL IDENTIFICATION: _____

WELL CONSTRUCTION START DATE: _____
WELL CONSTRUCTION COMPLETE DATE: _____

SCREEN MATERIAL: _____
SCREEN DIAMETER: _____
STRATUM-SCREENED INTERVAL (FT) _____

CASING MATERIAL: _____
CASING DIAMETER: _____

TYPE OF FILTER PACK: _____
GRADIATION: _____
AMOUNT OF FILTER PACK USED: _____

TYPE OF BENTONITE: _____
AMOUNT BENTONITE USED: _____

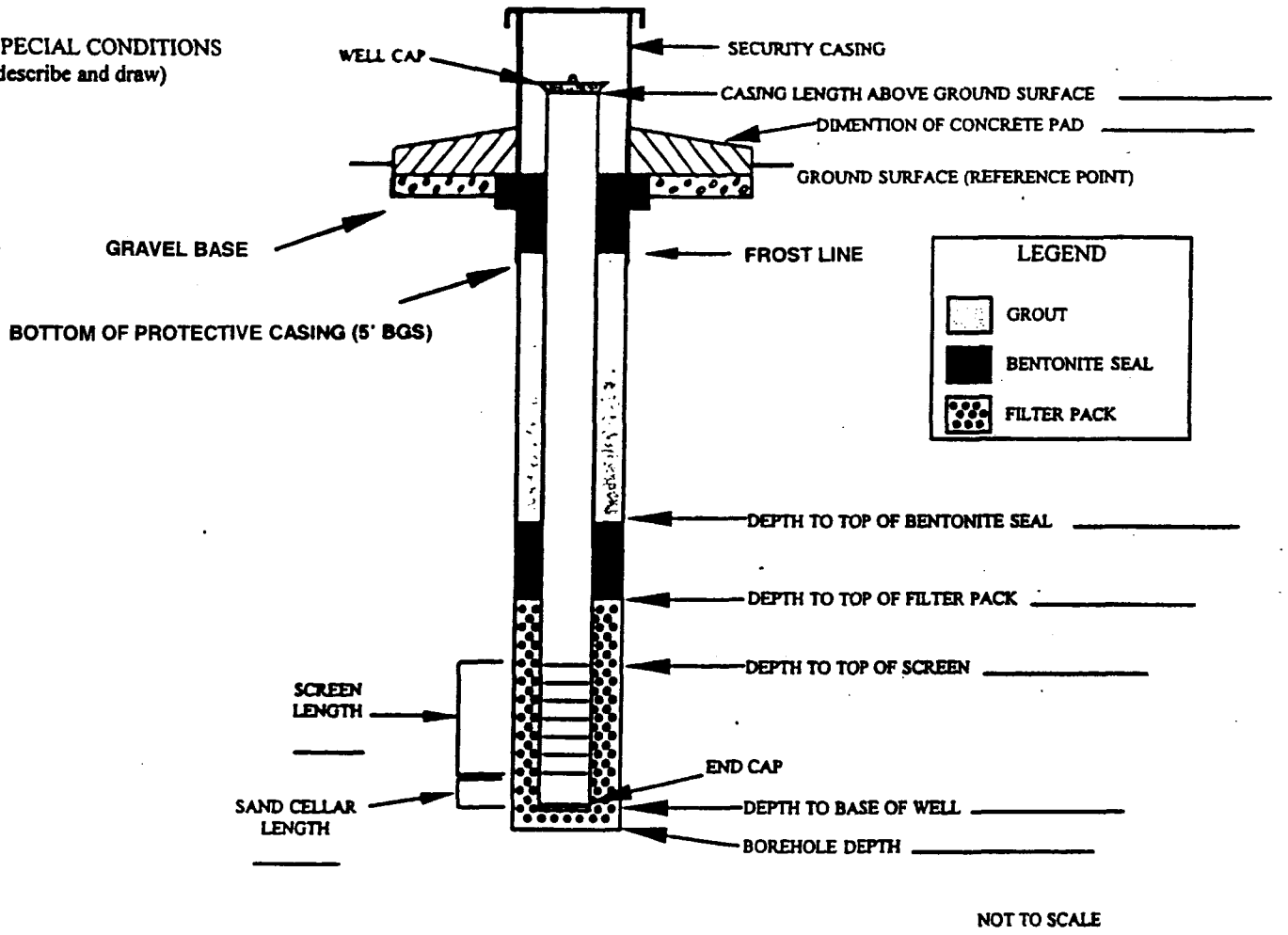
TYPE OF CEMENT: _____
AMOUNT CEMENT USED: _____
GROUT MATERIALS USED: _____

DIMENSIONS OF SECURITY CASING: _____

TYPE OF WELL CAP: _____
TYPE OF END CAP: _____

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____

DISCREPANCIES: _____

Figure 5-2

WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

FIELD REPRESENTATIVE: _____

DRILLING CONTRACTOR: _____

DRILLING TECHNIQUE: _____
AUGER SIZE AND TYPE: _____

BOREHOLE IDENTIFICATION: _____
BOREHOLE DIAMETER: _____
WELL IDENTIFICATION: _____

WELL CONSTRUCTION START DATE: _____
WELL CONSTRUCTION COMPLETE DATE: _____

SCREEN MATERIAL: _____
SCREEN DIAMETER: _____
STRATUM-SCREENED INTERVAL (FT): _____

CASING MATERIAL: _____
CASING DIAMETER: _____

TYPE OF FILTER PACK: _____
GRADIATION: _____
AMOUNT OF FILTER PACK USED: _____

TYPE OF BENTONITE: _____
AMOUNT BENTONITE USED: _____

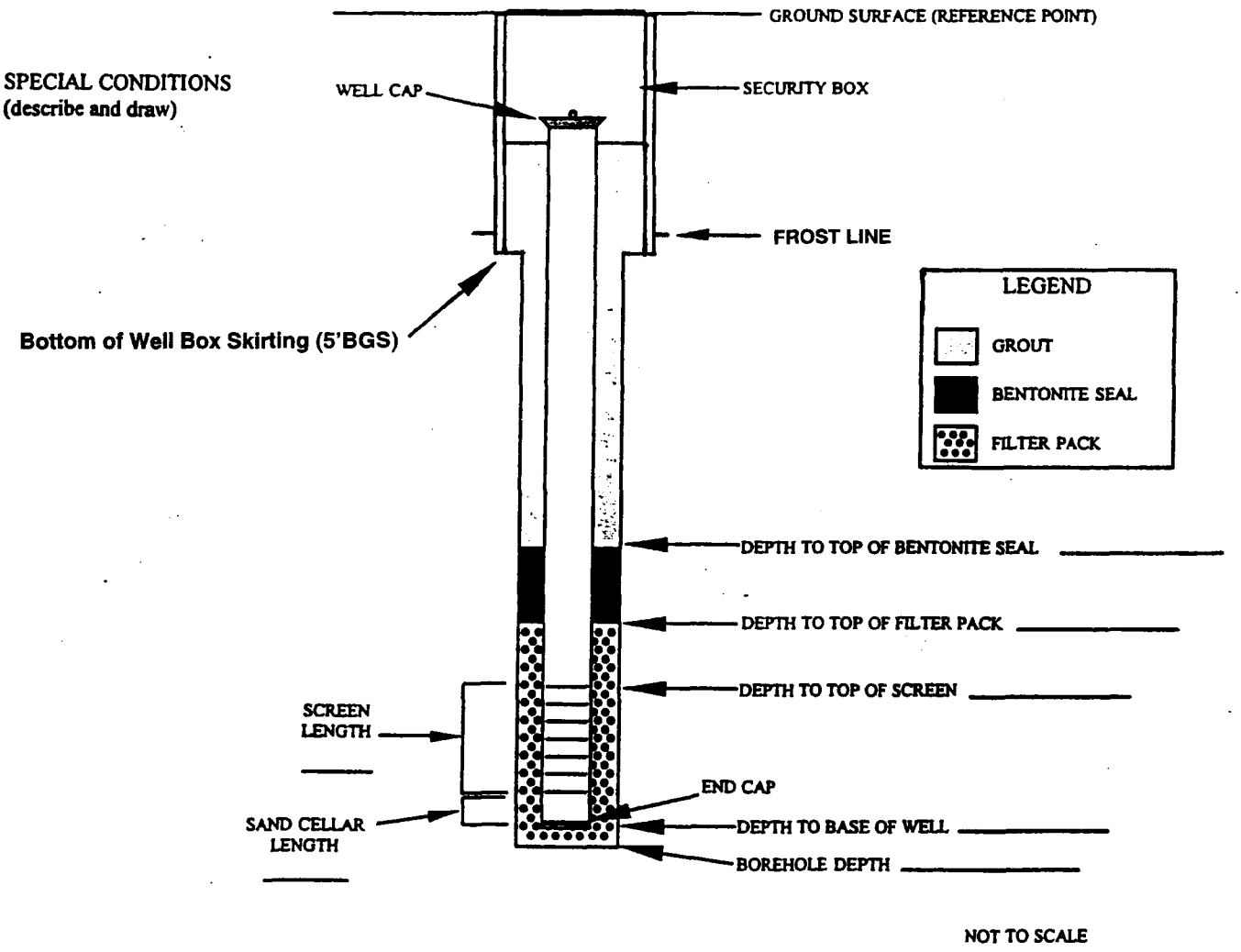
TYPE OF CEMENT: _____
AMOUNT CEMENT USED: _____
GROUT MATERIALS USED: _____

DIMENSIONS OF SECURITY BOX: _____

TYPE OF WELL CAP: _____
TYPE OF END CAP: _____

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____

DISCREPANCIES: _____

Figure 5-3

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID _ _____
SHEET _____ of _____

PROJECT NAME: _____ PROJECT NO. : _____ DATE: _____

LOCATION: _____ DATE INSTALLED: _____

TOTAL DEPTH (FTOC) _____ CASING DIAMETER _____

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐ Describe _____

Equipment decontaminated prior to development ☐ Yes ☐ NO

Describe _____

EQUIPMENT NUMBERS:

pH Meter _____ EC Meter _____ Turbidity Meter _____ Thermometer _____

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION:

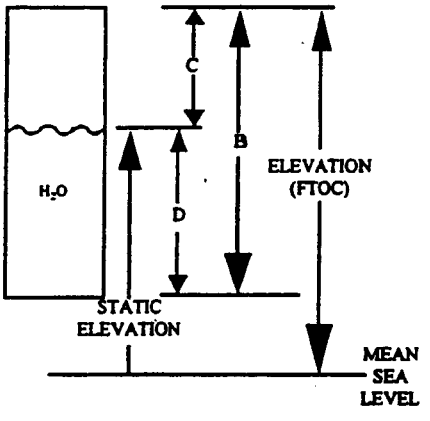
Measured Well Depth (B) _____ ft.

Measured Water Level Depth (C) _____ ft.

Length of Static Water Colume (D) _____ - _____ = _____ ft.
_____ (B) (C)

Casing Water Volume (E) + _____ x _____ = _____ gal
(A) (D)

Total Purge Volume = _____ (gal)



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature F or C	Turb. (NTU) Sand (ppm)	Comments

Figure 5-4

MONITOR WELL STATIC WATER LEVEL FORM

PROJECT NAME: _____ DATE: _____

WATER LEVEL INDICATOR ID # _____ FIELD BOOK # _____

LOCATION: _____ PAGE # _____

Monitor Well Number	Total Well Depth	Well Screen Length	Measuring Point Elev.	Time	Depth to Static Water Level	Sounding	Explosimeter Reading (above background)	PID Reading (above background)

Note: Total well depth to be measured at time of gauging.

Comments: _____

_____

_____

Sampler _____ Observer _____

Figure 5-5

MONITOR WELL PURGING FORM

PROJECT : _____ DATE: _____

LOCATION: _____ EXPLOSIMETER BOREHOLE READING _____

WELL ID: _____ PURGE VOLUME
(3 WELLBORE VOLUMES): _____ (gal)

WELL DEPTH: _____

Time	Depth to Water (ft)	Flow Meter Reading	Volume Purged (gal)	Temp. (°C)	pH	Electrical Conductivity (mmho)	Turbidity N.T.U	Comments

Note: Condition of the well: _____

pH - Calibrate at start and before last reading.

Sampler _____ Observer _____

Figure 5-6

Figure 5- 7

GROUNDWATER SAMPLING FIELD DATA FORM

Location ID: _____ COC Sample Numbers _____
Plume Area: _____ Well Number: _____
Arrival Date/Sample Time: _____/_____
Sampling Method : _____

Pump # _____	Pump Length _____
Dedicated Pump Used _____	

Weather:

Well Total Depth : _____ ft BTOC. Screened Interval : _____ ft BTOC.
Background PID Reading : _____ PPM. Well PID Reading : _____ PPM.
Static Water Level : _____ ft BTOC. Pump Set Depth : _____ ft BTOC
LNAPLS Present : _____ DNAPLS Present : _____

Purge volume calculations:
(D_c) Casing diameter (inches) _____ , (H_s) Length of saturated screen interval (feet)_____,

(Db) Well boring diameter (inches) _____, (P) Effective porosity of filter pack (dimensionless) = 0.3

(A) Well Screen Unit Volume = $0.041\ (D_c)^2\ (H_s)$ = _____

(B) Saturated Filter Pack Unit Volume = $0.041\ [(D_B)^2 - (D_C)^2]\ (H_S)P$ = _____

(C) Total Unit Volume = (A) + (B) = _____

(D) Purge Volume = 3 * (C) = _____

Analytical Parameters

Collected	Parameters	Method	Preservatives

QA/QC Sampling: Sample Duplicate: NO __; YES __ Well Number
MS/MSD Sample: NO __; YES __ Well Number:
Rinsate Blank: NO __; YES __ Well Number:
Field Blank: NO __; YES __ Well Number:

Sample Crew (Print):

(continues)

Note: It is the user's responsibility to verify with their supervisor that they are using the most current version of this document.

Well ID _____

Sample Date: _____

Figure 5 -7

GROUNDWATER SAMPLING FIELD DATA FORM (continued)

Final Well Purging - Field Water Quality Measurement Table

		)		Temp (C)	pH	Sp. Cond. (mS/cm)	Turbidity (NTUs)	DO (mg/L)	ORP (mV)	Comments
Time	Depth to Water (ft)	Purge Rate (ml/min)	Total Purge (gal)	Stab. Para. (± 0.5 deg.)	Stab. Para. (± 0.2)	Stab. Para. (± 3%)	Stab. Para. (± 10%)	Stab. Para. (± 10%)	Stab. Para (+/- 10 mV)	Stabilization Parameters
										Final Field Parameters

Note: It is the user's responsibility to verify with their supervisor that they are using the most current version of this document.

Field Equipment: PID/OVA SN: _____ Calibration Date: _____ Initials :

YSI SN: _____ Calibration Date: _____ Initials :

Field measurement protocols followed with no exceptions (Y / N*) Form completed by : _____
Date :

*Field Deviations Made :

_____

_____

Note: It is the user's responsibility to verify with their supervisor that they are using the most current version of this document.

SLUG TEST DATA FORM

SLUG TEST DATA

LOCATION _____ SLUG VOLUME (FT^3) _____

LOCATION I.D. _____ LOGGER CODE _____

LOGDATE _____ ACCEPTANCE CODE _____

TEST METHOD: [ ] SLUG INJECTION OR [ ] SLUG WITHDRAWAL

COMMENTS: _____

_____

_____

ELAPSED TIME (MIN)	DEPTH-TO-WATER (FT)	ELAPSED TIME (MIN)	DEPTH-TO-WATER (FT)
0.00			

ACCEPTANCE CODES: A - ACCEPTABLE R - RECONNAISSANCE U - UNACCEPTABLE N - NOT DETERMINED

_____ _____

FORM COMPLETED BY / DATE TECHNICAL REVIEWER / DATE

Figure 5-8

AQUIFER TEST DATA FORM

AQUIFER TEST DATA

LOCATION _____ SLUG VOLUME (FT^3) _____

LOCATION I.D. _____ LOGGER CODE _____

LOGDATE _____ ACCEPTANCE CODE _____

TEST METHOD: _____

COMMENTS: _____

_____

_____

ELAPSED TIME (MIN)	DEPTH-TO-WATER (FT)	ELAPSED TIME (MIN)	DEPTH-TO-WATER (FT)
0.00			

ACCEPTANCE CODES: A - ACCEPTABLE R - RECONNAISSANCE U - UNACCEPTABLE N - NOT DETERMINED

_____ _____

FORM COMPLETED BY / DATE TECHNICAL REVIEWER / DATE

Figure 5-9

Jacobs Engineering Group
125 Broadway Oak Ridge, TN 37830 Attention Mike Houck
Phone: (865) 220-4866 Fax: (220) 220-4848

COC # CH-L2572

CHAIN-OF-CUSTODY RECORD

Project Name:	Example Project	**Laboratory:**	Ecology and Environment
Project Number:	42K12345	**Point of contact:**	Alan Laffin, Analytical Services Center
WBS Code:	320606503	**Ship to:**	4493 Walden Ave, Lancaster NY 14086

Comments:

	Control Number	Matrix	Date	Time	Samp Init.		SW8260B VOLATILES	SW8081A PESTICIDES	SW8082 PCBS	SW8270C SEMIVOLATILES	SW8310 PAH	SW6010B ICP METALS	SW7470A MERCURY	SW9012A CYANIDE	SW160.1 TDS	SW160.2 TSS	E310.1 ALKALINITY	SW9056 ANIONS	E340.2 FLUORIDE	E375.4 SULFATE as (SO4)	E353.2 Nitrogen, Nitrate (as N)	E365.2 Phosphorus (as P)	SW9060 TOC	Sample Number	Location Name	Samp Type	Depth (ft bgs)* Top	Depth (ft bgs)* Bottom
							1					2		4									6					
1	CH-L257201	WG	08/14/02	8:30			X	X	X	X														WG-WL-1045-LF4-02	WL-1045	N1	27.50	30.25
2	CH-L257202	WG	08/14/02	8:30		X																		WG-WL-1045-LF4-02	WL-1045	N1	27.50	30.25
3	CH-L257203	WG	08/14/02	8:30							X	X												WG-WL-1045-LF4-02	WL-1045	N1	27.50	30.25
4	CH-L257204	WG	08/14/02	8:30									X											WG-WL-1045-LF4-02	WL-1045	N1	27.50	30.25
5	CH-L257205	WG	08/14/02	8:30										X	X	X		X	X					WG-WL-1045-LF4-02	WL-1045	N1	27.50	30.25
6	CH-L257206	WG	08/14/02	8:30																			X	WG-WL-1045-LF4-02	WL-1045	N1	27.50	30.25
7																												
8																												

Cooler #: Turnaround Time: Equipment:

Relinquished By: (Signature)	Date	Time

Received by: (Signature)	Date	Time

Shipping Date / Cooler / Airbill Number

Received for Laboratory: (Signature) Date / TAT / Acknowledgment

Code	Container/Preservative
	3 - 40 mL VOA 4C HCL
	6 - 1 L Amber Glass 4 deg C
	1 - 1 L Plastic 4C HNO3
	1 - 1 L Plastic 4C NAOH
	1 - 1 L Plastic 4 deg C
	1 - 1 L Plastic H2SO4

* Bottom depth should not equal top depth

Figure 6-2

Example Sample Container Label

CH-L257201	
WG	SW8260B ____
	SW8081A ____
Date/Time	SW8082 ____
	SW8270C ____
	SW8310 ____
	SW8330 ____
Preservative	SW6010B ____
None___ NAOH___	SW7470A ____
HCL___ H2SO4___	SW9012A ____
	E160.1 ____
Samplers	E160.2 ____
	E310.1 ____
	SW9056 ____
General Engineering Laboratories	
Attn: Jake Crook	
2040 Savage Road, Charleston SC 29414	

WASTE INVENTORY TRACKING FORM

LOCATION : _____

PROJECT NAME: _____

ACTIVITIES: _____

Date Waste Generated	Activity Generating Waste (borehole # / well #)	Description of Waste	Field Evidence of Contamination	Estimated Volume	Type of Container (storage ID#)	Location of Container	Waste Characterization	Comments

Note: Describe whether soil or water samples have been collected for waste characterization, include date, if known.

Signature: _____

Figure 8-1

DAILY QUALITY CONTROL REPORT

PROJECT NAME: _____ DATE: _____

USACE CONTRACT: _____

Jacobs PROJECT NO.: _____

WEATHER: _____

_____

_____

DEPARTURES FROM APPROVED WORK PLANS: _____

_____

_____

_____

_____

_____

PROBLEMS: _____

_____

_____

_____

REMARKS: _____

_____

_____

_____

_____

_____

USACE INSTRUCTIONS: _____

_____

_____

_____

_____

CQC REPRESENTATIVE: _ SIGNATURE: _____

Attach additional sheets as necessary

Figure 9-1

Figure 10-1

Jacobs Engineering Group

PAGE_____

VARIANCE LOG

NCR NO.	CAR NO.	RESPONSIBLE PERSON	PROJECT/LOCATION	VARIANCE DESCRIPTION	DATE ENTERED	DATE CLEARED

Figure 10-2

Jacobs Engineering Group

PAGE_____

NONCONFORMANCE LOG

NCR NO.	CAR NO.	RESPONSIBLE PERSON	PROJECT/LOCATION	NONCONFORMING DESCRIPTION	DATE ENTERED	DATE CLEARED

Note: It is the users' responsibility to verify with their supervisor that they are using the most current version of this document.

Figure 10-3

NONCONFORMANCE REPORT	
SECTION A — TO BE COMPLETED BY INITIATOR	
Item of nonconformance:	NCR number:
Location of nonconforming item:	Date:
Name, function, and telephone number of person initiating NCR	Date nonconformance discovered:
Individual(including function) responsible for the resolution of the nonconformance:	
REF: SOP, SAP WORK PLAN, DWG, etc.	
Project(s) affected.	
Description of nonconformance: (1) identification of the nonconforming item or service; (2) requirements, including the specific reference document by title, revision, and its unique identification number; and (3) as found conditions:	
Signature of initiator:	Date:
Quality Coordinator's concurrence:	Date:
STOP WORK order required? Yes No	CAR required? Yes No
SECTION B — TO BE COMPLETED BY THE RESPONSIBLE INDIVIDUAL	
Responsible individual/function:	
Proposed resolution: Root cause: Actions taken to prevent recurrence: Expected date of completion:	
Responsible individual:	DATE:

Rev.0 (12/97)

Note: It is the users' responsibility to verify with their supervisor that they are using the most current version of this document.

Figure 10-3 (Concluded)

SECTION C	TO BE COMPLETED BY THE QUALITY COORDINATOR OR DESIGNEE
Proposed Corrective Actions outlined in Section B ☐ Accepted ☐ Conditionally Accepted ☐ Rejected Remarks:	
Results of verification of corrective action:	Date:
Quality Coordinator's closure of NCR:	Date:

Rev.0 (12/97)

Note: It is the users' responsibility to verify with their supervisor that they are using the most current version of this document.

FSP Appendix

14 April 2004

SUBJECT: Response to review comments for the Draft Site-Wide Sampling and Analysis Plan, Part 1, Field Sampling Plan, Former Plum Brook Ordnance Works, Sandusky, Ohio, February 2004, Prepared by Jacobs Engineering Group, Inc., Contract Number DACW62-03-D-0004-0002

Reviewer: CELRN - Becky Terry

1. Cover Page. *Plumbrook* should be *Plum Brook*.

Response: The correction will be made.

2. Completion of Independent Technical Review. It might be more appropriate to have Virgil Jansen sign the review page as Project Manager Review, rather than the independent technical review. Also, it may be appropriate to have the author sign with his/her discipline.

Response: Agreed. The suggestions will be incorporated in future ITRs.

3. List of Acronyms. Add the following: JRG, QAO, SWSAP, SAPA.

Response: The identified acronyms will be added. JRG should read JE and will be changed.

4. Page 3-1. First paragraph. First sentence. Add "District" after Nashville.

Response: The requested change will be made.

5. Page 3-1. Last paragraph. Shouldn't Jacobs Engineering be added to the list of data users?

Response: Agreed. Jacobs will be added to the list of end-users.

6. Page 3-2, Section 3.2. Last paragraph. Suggest adding EM 1110-1-4000 Monitoring Well Design as a reference to Monitoring Well Installation.

Response: The suggested reference will be added.

7. Page 5-3, Section 5.4.1. Fourth paragraph. Most current revision of EM 1110-1-4000 is (1998).

Response: The most current version will be referenced.

8. Page 5-5, 1st Bullet, 2nd Line. Add *less than 10 percent variation in specific conductivity.*

Response: The sentence will be rewritten to provide a more clear association between specific conductivity and the percent variation.

9. Page 5-8, Line 30. Suggest stating that work instructions will be provided in the site-specific sampling and analysis plans.

Response: A reference to work instructions will be provided.

10. Page 5-8, Section 5.4.5, 10th Sentence. Replace "*lest*" with test.

Response: The spelling error will be corrected.

11. Page 5-9, Section 5.4.5, 10th Sentence. Replace "*lest*" with test.

Response: The spelling error will be corrected.

12. Page 5-11, Section 5.5. Suggest adding a subsection that states the AE shall obtain a permit from NASA before any intrusive site investigative activities begin. The purpose of this permit is to identify any utilities that might be located within the area of the investigation. Also suggest providing a NASA point of contact in this new section.

Response: The recommended text will be included. The point of contact will be Bob Lallier

13. Page 5-11, Section 5.5.2. Second paragraph. Change Figure 4-1 to Figure 5-1.

Response: The figure reference will be corrected.

14. Page 5-11, Section 5.5.3. First paragraph. Suggest adding a statement that trenching is also being done to determine the extent of contamination.
Response: The recommended objective will be added.

15. Page 5-11, Section 5.5.5. This section and section 5.4.6 discuss decontamination. Suggest combining the two sections.

Response: The current document organization follows the EM-200-1-3 guidance, which addresses decontamination procedures separately under each field investigation subsection. Jacobs will leave the organization as is unless directed by CELRN.

16. Page 5-12, Section 5.6. First paragraph. Aren't the sediments being investigated to determine if the sediments have been impacted from adjacent AOCs?

Response: The first sentence will be rewritten to clarify that sediment is considered a component of the surface water feature.

17. Page 5-13, 2nd Paragraph, 2nd Sentence. Should this sentence be, "*Sampling will be conducted in a manner* that does *not* disturb sediment…into the water sample"?

Response: Yes. The sentence will be corrected.

18. Page 5-14, Section 5.9.1. Suggest adding that NASA will also be consulted before any new control monuments are added.

Response: Agreed. The suggested requirement will be added.

19. Page 5-14, Section 5.7. First paragraph. Change the reference from Section 8.0 to Section 6.0.

Response: The section reference will be corrected.

20. Page 8-1, Section 8.0. Suggest adding a discussion of approximately how long we believe it will be necessary to store the IDW.

Response: Durations for IDW storage will be added to this section.

21. Page 9-2, Section 9.2. Second paragraph. Change reference from LHAAP to PBOW.

Response: The reference will be corrected.

22. Page 5-1, section 5.0. Add a section on rock coring, logging, boxing and photographing. CELRN will provide a Field Manual to assist with logging rock and soil samples.

Response: Rock coring and associated tasks will be added as a bullet in section 5.0 and a paragraph will be added in Section 5.4.1.

23. Page 5-3, section 5.4.1,3rd paragraph. The boring log to be used should be ENG 5056-R and 5056A-R as specified in EM 1110-1-4000.

Response: The drilling log Figure 5-1 will be replaced with the requested forms.

24. Page 5-3, section 5.4.1, 4th paragraph. The current version of EM 1110-1-4000 is November 1998. Check for the current version of all references.

Response: The date will be corrected.

25. Page 5-3, section 5.4.1, 4th paragraph. The filter pack may be 3-5 feet above the top of the screen.

Response: The parameters for the filter pack will be edited to include up to 5 feet of total thickness above the top of screen.

26. Page 5-4,2nd full paragraph. The well installation diagram (Figures 5-2 & 5-3) do not agree with this paragraph. Correct figures.

Response: The figures will be corrected to reflect the surface completion requirements.

27. Page 5-4, section 5.4.2. Third bullet does not conform to EM 1110-1-4.

Response: The stabilization values will be corrected , as specified in EM-1110-1-4000, to read as +/- 0.2 for pH, +/- 1 degree C for temperature, +/- 3% for conductivity, +/- 10 mV for ORP, and +/- 10% for DO and turbidity.

28. Page 5-6, section 5.4.3. Water levels should always be taken from the survey mark placed on the well riser.

Response: The reference point will be changed from the highest point on the riser to survey mark on the riser.

29. Page 5-7. Wells should not be sampled sooner than 14 days after development unless approved by CELRN. Please give rational for the 2 day period.

Response: The groundwater recovery period will be changed to 14 days. An additional mobilization will be required, since the original proposal was based on one trip for installation, development, and sampling.

30. Page 5-8, 1st bullet. Include values for the monitored parameters. Also the parameters given on Figure 5-7 do not conform to EM 200-1-3.

Response: The stabilization values will be included, as specified in EM 200-1-3, Appendix C, which will read as +/- 0.2 for pH, +/- 1 degree C for temperature, +/- 3% for conductivity, +/- 10 mV for ORP, and +/- 10% for DO and turbidity.

31. Page 5-10, section 5.5.1. Is this only for VOC samples? Encore samplers do not use stainless steel sleeves.

Response: The Encore sampler will be for VOC samples only. The text will be revised to indicate Teflon sleeves rather than stainless steel and will include other equivalent sampling devices to the Encore.

32. Page 5-10, section 5.5.2. The first and second paragraphs seem to contradict each other. Is the first paragraph only for VOC samples?

Response: This section will be revised to provide a clear distinction between VOC and non-VOC sample collection.

33. Page 5-14, section 5.9.2. Horizontal coordinates are to be to the nearest 1.0 foot.

Response: The survey requirements will be changed accordingly.

34. Page 10-1, section 10.1. All variances must be approved by CELRN prior to implementation.

Response: CELRN will be added to the list of required approvers in the 3rd sentence.

35 . Page 10-1, section 10.2. Add "PM" and "QAO" to the Acronym List.

Response: The acronyms will be included.

Subject: Response to review comments for the Site-Wide Sampling and Analysis Plan, Remedial Investigation, Part 1, at Reservoir No. 2 Burning Ground (2BG), Former Plum Brook Ordnance Works, Sandusky, Ohio, March 2004, prepared by Jacobs Engineering.

Reviewer Name: **Groenjes, Cheryl (Chemistry) – HTRW Center of Expertise**

Comment # 1: FSP p.5-8. There is no benefit in analyzing a sample for dissolved explosives. I have gleaned some facts from a technical resource on explosives for consideration: Suggest deletion of this protocol.

8.2 Considerations When Sampling Explosives

Because of the physical properties of explosives, they do not readily volatilize from solution or dissociate in solution (i.e., form charged species). They are also relatively hydrophilic and thus do not tend to sorb or partition into organic matter. Thus, we would expect that these analytes would not have a great affinity for other solid phase materials, particulates, or colloids. Therefore, high turbidity in samples, mobilization of colloids during sampling, and colloidal transport in groundwater are not significant issues when sampling for explosives.

8.7 Sample Collection, Handling, and Storage

Groundwater containing explosives should be collected in amber glass bottles to prevent photodegradation. For low concentrations (ppb levels), a 1-liter bottle is required. The sample does not need to be filtered but should be acidified to a pH of 2 using sodium bisulfate (Jenkins et al., 1995) and kept cold (4 °C). Because of the relatively low solubility of explosives in water, there are no special safety concerns associated with shipping groundwater samples containing explosives.

Response: Agreed. Groundwater samples will only be analyzed for total explosives, and they will be collected in one liter amber glass containers preserved with sodium bisulfite (ph<2).

Comment # 2: FSP p. 5-10, 5.5.1.

a. The use of the term QA to describe field QC samples such as rinsates is not recommended. The "QA" term is used by the Corps to represent a replicate sample sent to a referee laboratory, which is correctly presented later in the SAP (QAPP 2.2).

Response: Agreed. QA will be changed to field QC samples.

b. Encore samplers are not composed from stainless steel, nor do they use sleeves, end caps or Teflon tape. The procedures are not applicable to the device. Suggest revising to protocols obtained from En Novative Technologies, Inc. at http://www.ennovativetech.com/encore/encore.htm . The T-handles and extrusion devices may be made of stainless steel, but they do not come in contact with the sampled media.

Response: Agreed. This procedure will be revised.

c. Protocols are not included that address the remaining samples to be acquired. Refer to EM 200-1-3, appendix E-5 for information on appropriate E-2 for homogenization of soil media for acquisition of samples for the remaining semi-volatile and non-volatile parameters.

Response: The second sentence in this section refers to the collection of non-VOC samples using a stainless steel bowl and spoon. Homogenization of the soil will be added to the protocol.

Comment # 3: FSP p. 5-10, 5.5.2. Along the same lines as comment 2a and 2b, protocols must be included within this section to address the appropriate sample handling procedures for subsurface soils. Refer to EM 200-1-3, appendices E-5 for VOCs, and E-2 for homogenization techniques and acquisition of remaining parameters.

Response: This section will be revised and will include sampling protocols for VOC and non-VOC samples

Comment # 4: FSP p. 5-11, 5.5.3. Refer to EM 200-1-3, E-2 for appropriate procedures for homogenization of soils prior to acquisition of non-VOC parameters.

Response: This section will include sampling protocols for non-VOC samples.

Comment # 5: FSP p. 5-12, 5.6. Appropriate sediment sampling devices are not identified within this document, nor are referenced SOPs provided. Suggest including basic information on the type (grab, core, etc.) to be used for sampling of sediments and/or including the noted SOPS within this comprehensive SAP.

Response: Sampling devices are discussed in the 4th paragraph. The Jacobs work instruction is included in the 6th paragraph. The use of a stainless steel spoon to collect non-VOC samples will be included in this section.

Comment # 6: FSP p. 5-13, 5.7.

a. 3rd paragraph. I'm unfamiliar with the use of a rod to extend the peristaltic intake line to the appropriate depth. Suggest replacing with the use of Teflon tubing for ease of use (can be dedicated) and cut to appropriate lengths based on water measurements of the SW body. If the rod is retained, define its length, composition, and how it will be deconned. How do you vary the length?

Response: Additional descriptions will be provided for this sampling protocol. The use of a rigid rod allows the sampling technician to properly place the intake line without entering the water. The tubing will be lashed to the rod and will extend approximately 3 inches beyond the end of the rod. The length of the rod needs to be sufficient to reach the desired sampling point. The rod never comes in direct contact with the water and therefore does not require decontamination. This approach as stated in the text is used in circumstances where entry into the water by the sampling technician would result in turbid samples. Tygon tubing will be used and disposed after each sampling location.

b. 4th paragraph. The use of the lid when filling VOC vials should be suspended. Suggest the low-velocity stream of SW flow down the (inside) sidewalls of the vial as it fills. Suggest a caution to prevent over-filling be added to the discussion on obtaining a convex meniscus – for that is when you wash out the preservative.

Response: The text will be revised to include a partial fiilling of the vial by direct fill methods when feasible. The final amount however will be collected with the lid to form a proper meniscus and to avoid flushing the preservative from the vial. The use of the lid for creating a meniscus is standard practice with groundwater sampling and should be allowed for surface water sampling.

c. Refilling of the vials do not result in the loss of preservative – the discarding of the previous sample causes the loss. Refilling of the vial requires preservation be done from bulk preservatives brought to the field. Augment this section to address these omissions.

Response: The intent of this section was to provide instruction to avoid discarding the sample and refilling of a vial. Additional clarification will be provided to indicate that new preserved vials will be used.

Comment # 7: FSP p. 6-6, 6.4. No analytical is described in this paragraph. Edit heading to what is discussed.

Response: This section discusses field documentation of analytical samples. It describes the types of information about the analytical samples that will be recorded while in the field.

Comment # 8: FSP p. 7-1, 7.0. Filtration techniques should be performed in the field as soon as possible to maintain sample integrity and comparability in data. Edit text here for compliance with that stated in section 5.4.4 on GW sampling.

Response: The option to send unfiltered samples to the laboratory for lab filtration will be removed.

Comment # 9: FSP p. 8-1, 8.2. The use of RBCs as a comparative value for IDW is unfounded and inappropriate. Suggest as an alternative, that the results for the associated samples be used along with the 20 times rule to evaluate a very conservative (assumes 100% is leachable) estimate for the associated TCLP value. I can provide a white paper on this approach if desired to help convey this evaluation. These estimated values for the TCLP can then be compared directly to the RCRA standards outlined in 40 CFR 261.20 through 261.24.

Response: IDW segregation based on analytical results is simply a method to consolidate soil into logical populations prior to routine waste characterization (TCLP, ignitability, corrosivity, and reactivity). This will minimize the number of characterization samples needed and will prevent non-hazardous material from being mixed with potentially hazardous material. Disposal options are not going to be based on RBC comparisons.

Comment # 10: FSP p. 9-2, 9.2. Typo LHAAP → PBOW.

Response: The typo has been noted and will be corrected.

Comment # 11: QAPP p. 6, 3.2.1. Suggest method modification needs be evaluated in light of project-specific COC or COPCs - and discussed here in order to optimize data generated as useful for its intended purpose.

Response: A statement will be added to the section suggesting that method modifications be explored as a possible way to achieve some of the screening criteria for COCs that are outside the realm of the normal analytical method capabilities.

Comment # 12: QAPP p. 12, 5. Refer to EM 200-1-3, section I.3.3.7.2 and I.3.3.7.3 for details on how results must be qualified (J-flagged) to relate the estimation of values reported below the MQL – which is 3-times the MDL. MRL can report down to MDL or 2xMDL – but the values must be J-flagged.

Response: Section 5.1 will be amended to include the qualification of estimated data. Section will also be corrected for the three times the MDL rule. For the purposes of this QAPP the MQL and MRL are intended to be the same value. The MRL definition will be corrected to reflect the requirement for being at least 3x greater than the MDL.

Comment # 13: QAPP p. 16, 5.4.3.1. The MB criteria established in the Shell (I.11.4.1) for the majority of compounds (all except common contaminants to ½ MRL.

Response: Agreed. The language will be amended to require the analytical subcontractors to report the method blanks to ½ the MRL rather than to the MDL. The method blanks will be evaluated per the shell requirements (to ½ the MRL, except common laboratory contaminants).

Comment # 14: General and QAPP p. 40, table 3-1.

a. The acceptance criteria noted here are oversimplified for the sake of brevity. However, the following does not represent what is presented within the EPA SW-846 methods or the Shell for Analytical Chemistry Requirements (Appendix I) of EM 200-1-3. Method 8260B ICAL is not compliant with 8260B 7.3.6.2 and Shell I.9.2.2. CCC only evaluation is not correct – must be all target analytes for ICAL. The use of the mean %RSD or mean %D requires additional documentation and constraints as noted in the last paragraphs of I.9.2.2. Suggest the adoption of footnotes or other means to ensure compliance.

b. Method 8330 must be modified slightly to detect and quantitate for PETN. The same extract can be used, however, the UV wavelength for PETN detection is at 210nm, with the remainder of the nitroaromatics being monitored at 254nm established within the method. This change is not a typical method option, nor is it addressed within the method. Therefore these details must be addressed within the appropriate QAPP documents.

Response: a) The table will be expanded to fully list the requirements of the methods and the Shell document.

b) PETN is not currently a target analyte of concern at this site. If the scope changes to include the need for analysis of PETN, the modifications will be added to the site specific QAPP.

Reviewer Name: Crain, Mike (Geology) – HTRW Center of Expertise

Comment # 1: Field Sampling Plan, 5.5.2, 2nd par, pgs 5-10 and 5-11 – The criteria for selection of soil samples for laboratory analysis need to be established in the site specific work plans based on the data needs and data quality objectives for each sampling effort. During the planning process, the project team needs to decide which criteria are the most appropriate for the contaminants of concern and the intended use of the data and then provide the field geologist with some type of decision matrix to follow that communicates the goals and objectives in a way that they can use in the field.

Response: Agreed. The Site-Specific SAP addresses the investigation DQOs and provides decision criteria for field implementation.

Comment # 2: Field Sampling Plan, 5,7, pg 5-13, 2nd paragraph – There appears to be an omission in the second sentence. Should the sentence say "Sampling will be conducted in a manner that does *not* disturb sediment..." Please correct or clarify as appropriate.

Response: Yes. The word "not" was omitted. The sentence will be corrected.

Comment # 3: Field Sampling Plan, 5.9 pg 5-14 – The elevation of the control monuments need to be measured at least to the nearest 0.01 foot to allow the elevations of the monitoring well casings to be measured to the nearest 0.01 foot. The control monuments actually have to be established with a greater degree of precision than the monitoring wells. The precision specified for the monitoring wells is appropriate but the precision for the control monuments needs to be lowered, preferably to 0.005 foot.

Response: This section will be revised. It has been determined that adequate control monuments exist at the facility. Additional monuments will not be required.

Reviewer Name: Charles G. Coyle (Env. Engineer) – HTRW Center of Expertise

Comment # 1: p. 5-7, 5.4.4 The text states that low-flow purging will be performed at a rate that allows for stabilization of the water column at a level no lower than 4" below original pre-pumping levels. Concur that this is a reasonable criteria for the low-flow sampling procedure. Recommend revising to explain how water level will be monitored during sampling.

Response: The text will include a discussion on constant water level monitoring during purging. Water level measurements will be recorded along with water quality parameters and purge volumes.

Comment # 2: p. 5-8, 5.4.4 The text states that during purging and sampling field measurements of pH, Eh, temp, turbidity and conductivity will be performed every 5 minutes. Dissolved oxygen is generally a more reliable indicator of redox conditions than Eh (except for in anaerobic zones). Recommend revising to require testing for dissolved oxygen as one of the field measurements.

Response: Agree. Monitoring for DO is planned but was omitted from the text. The text will be revised to include DO

Comment # 3: p. 5-8, 5.4.4 This section should be revised to require testing for Mn II and Fe II immediately after sampling is performed, in the field, using a HACH or equivalent field test kit. Note that after 1 or 2 rounds of sampling, if it is determined that Mn II levels are insignificant, further Mn II testing could be eliminated.

Response: The comment is acknowledged. Specific sampling requirements are addressed in the Site-Specific SAP.

Comment # 4: p. 5-10, 5.5 Note that data on TOC levels (in groundwater, soil from the aquifer matrix, and also from sediments), will be important from a natural attenuation perspective (especially with regard to adsorption and irreversible binding of nitroaromatics, see Haderlein,

S.B., Schwarzenbach, R.P; Environmental Processes Influencing the Rate of Abiotic Reduction of Nitroaromatic Compounds in the Subsurface. In: «Biodegradation of Nitroaromatic Compounds», J.C. Spain (Ed.). Plenum Press, New York 1995, pp.199-225. [1993). During future investigation work in areas where nitroaromatics are present, recommend requiring that groundwater, aquifer soil and sediment samples be tested for TOC.

Response: The comment is acknowledged. Specific sampling requirements are addressed in the Site-Specific SAP.

RE: NASA Plum Brook Station
Erie County

April 28, 2004

United States Army Corps of Engineers
Nashville District
Attn: CELRN-EP-R-M (Ms. Linda Ingram)
Estes Kefauver Federal Building
801 Broadway
Nashville, Tennessee 37202-1070

Dear Ms. Ingram:

Please find below the response to comments for the commentary of the Ohio Environmental Protection Agency (Ohio EPA) with respect to the Site-Wide Sampling and Analysis Plan (SAP), Former Plum Brook Ordnance Works as well as the corresponding Site-Specific Quality Assurance Project Plan (QAPP).

General Comment
The Site-Wide SAP details general investigatory methodologies/protocols. Section 1.0 states that for those investigations at specific areas of concern at the former Plum Brook Ordinance Works detailed site-specific attachments to the SAP will be submitted. Ohio EPA concurs with this approach to have general investigatory methodologies/protocols in one document with accompanying and more detailed site-specific methodologies/protocols included as attachments as warranted.

Response: Jacobs agrees and will maintain this approach.

Section 3.2
The Site-Wide SAP states that ground water analytical data will be screened against maximum contaminant levels (MCLs) and United States Environmental Protection Agency (USEPA) Region III risk-based concentrations (RBCs) for Tap Water. Ohio EPA is not amenable to the above approach of standards comparison. In general, MCLs are "Applicable or Relevant and Appropriate Requirements" (ARARs) and, as such, are not considered appropriate as risk based values for the screening of constituents of concerns in ground water. Ohio EPA recommends the use of USEPA Region IX Preliminary Remediation Goals (PRGs) as the primary source of risk based screening values. Implementation of this strategy will ensure consistency with previous investigations in which PRGs were utilized. Please note that USEPA Region IX PRGs for non-carcinogens should be adjusted by a factor of 0.10 to allow for multiple chemical exposure screening considerations.

Response: Agree. The screening criteria will be amended to the Region IX PRGs.

Section 3.2
The Site-Wide SAP states that the classification and compliance determination of ground water will follow those criteria noted in Ohio Administrative Code Rule 3745-300-10 (i.e., the Voluntary Action Program or "VAP"). Utilization of the VAP investigatory approach and associated rule citations in support of the installation restoration program (IRP) investigation at the former Plum Brook Ordinance Works is inappropriate.

Response: Per discussions with John Weaver (OEPA) the objective to determine groundwater classification for the shallow overburden at Plum Brook has already been resolved. The OEPA has determined that the overburden groundwater at Plum Brook does not meet the standards for a drinking water source. The objective and discussion on groundwater classification for the shallow overburden will therefore be removed from the Site-Wide SAP.

Section 5.4
The Site-Wide SAP does not explicitly state what material will be used to construct the shallow (overburden) and bedrock monitoring wells. The material, along with a more detailed discussion of how the well material will be installed in the borehole, should be included in this section. Additional information pertaining to the equipment and techniques for coring the bedrock monitoring wells should be provided.

Response: This information will be provided and specific details will be provided in the Site-Specific SAP Section 5.0.

The purging information diagram on the Well Development Record (Figure 5-4) appears to be mis-labeled. The diagram does not contain an Item B but the 'measured well depth' is represented by Item E. This labeling disparity is carried through the formulas/calculations making it difficult to interpret and to determine the total purge volume. Ohio EPA recommends forgoing the use of the diagram in favor of providing the calculations and required fields of information.

Response: The typo will be corrected. Parameter "E" on the schematic diagram will be replaced with "B"

Section 5.4.3
The section should be revised to note the equipment that will be used for performing water level monitoring.

Response: The use of a Solinst SOL1 Water Level Meter or equivalent will be included in the text.

The Site-Wide SAP should identify the contracted laboratory and provide a table of practical quantification limits (PQLs) and method detection limits (MDLs) for all matrices. If the aforementioned information has yet to be determined, then it should be included in a site-

specific attachment. In addition, the Quality Assurance Project Plan (QAPP) for the contracted laboratory should be provided.

Response: The analytical subcontractors and their MRLs and MDLs will be provided in each of the Site-Specific SAPs for the specific matrices and methods for each specific project. The site-specific QAPP also contains the procedures for each applicable method from the primary and QA analytical subcontractors. Jacobs has received and reviewed the QAPPs for each analytical subcontractor as part of the development of the Site-Specific QAPP. Jacobs maintains the analytical subcontractor QAPPs on file and can provide them to the OEPA under separate cover upon request.

As general reminder, the contracted laboratory must be able to achieve PQLs or MDLs that provide the lowest limit of detection for the corresponding analytical method as specified in USEPA SW-846 Methods and that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Response: The laboratory MDLs are required to be determined per 40 CFR, Part 136, Appendix B or an equivalent statistical approach. The laboratory MRLs are required to be set at the laboratory MQL (or PQL) for this project to achieve as many of the project's risk based criteria as possible. In addition the analytical subcontractors are also reporting detected concentrations of target analytes down to their MDL values qualified as estimated "J".

An example sample container label should be provided in the Site-Wide SAP.

Response: Section 6.3.2 will be amended to include a reference to figure 6-2, the example label that will be included as part of the figures Section of the Site-Wide FSP.

QAPP

FINAL SITE WIDE QUALITY ASSURANCE PROJECT PLAN

FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

Prepared for:

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE
CONTRACT DACW62-03-D-0004-0002

Prepared by:

JACOBS ENGINEERING
Engineers and Constructors

JACOBS ENGINEERING GROUP, INC.
125 BROADWAY
OAK RIDGE, TN 37830

May 2004

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LIST OF ACRONYMS AND ABBREVIATIONS

CAR	Corrective Action Report
CDQR	Chemical Quality Data Report
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	chain-of-custody
CQAR	Chemical Quality Assurance Report
DQO	data quality objective
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
GC	gas chromatograph
GC/MS	gas chromatograph/mass spectrometer
HTRW-CX	Hazardous, Toxic, Radioactive Waste Center of Expertise
HPLC	high performance liquid chromatography
ICP	inductively coupled plasma
IDW	investigation-derived wastes
LCS	laboratory control sample
LDP	laboratory data package
MB	method blank
MD	matrix duplicate
MDL	method detection limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
MS/MD	matrix spike/matrix duplicate
MS/MSD	matrix spike/matrix spike duplicate
M&TE	measuring and testing equipment
NCR	Nonconformance Report
NFG	USEPA National Functional Guidelines for Data Review
NIST	National Institute of Standards and Technology
PE	performance evaluation
PID	photoionization detector
PJM	Project Manager
PM	Program Manager
QAPP	Quality Assurance Project Plan
QA	quality assurance
QC	quality control
QM	Quality Manager
RBC	risk-based criteria
RI	remedial investigation
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SM	Site Manager
SOP	standard operating procedure
VOC	volatile organic compound

1.0 PROJECT LABORATORY ORGANIZATION AND RESPONSIBILITIES

The Former Plum Brook Ordinance Works Program Sampling and Analysis Plan (SAP) includes this Quality Assurance Project Plan (QAPP) combined with the Field Sampling Plan (FSP), and provides the overall requirements for sample collection and analyses to ensure that the data collected is complete and of suitable quality for the decision-making purposes associated with the remedial investigations at the Former Plum Brook Ordinance Works in Sandusky, Ohio. The work is being performed by the United States Army Corps of Engineers, Nashville District (USACE). Jacobs Engineering has prepared this QAPP under Contract No. DACWL2-03-D-0004, Task Order Number 0002.

The United States Army Corps of Engineers (USACE) Hazardous Toxic Radioactive Waste Center of Expertise (HTRW-CX) EM-200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans* (Feb. 2001), provided the format and standard text used in the preparation of this QAPP. The United States Environmental Protection Agency (EPA), *Instructions on the Preparation of a Superfund Division Quality Assurance Project Plan* EPA, 2000, which is based on *EPA Requirements for Quality Assurance Project Plans, Interim Final* EPA QA/R-5, 1999, has also been reviewed and applicable requirements addressed in this document.

Jacobs will select analytical subcontract laboratories for the primary (QC) and the quality assurance (QA) sample analyses. The primary and QA analytical subcontractors selected to support this program will be determined on a project-specific basis and identified in the project-specific QAPPs. The analytical subcontractors selected to support this program must have been evaluated by the United States Army Corps of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste Center of Expertise (HTRW-CX). These subcontractors must hold current letters of validation from HTRW-CX to perform sample analyses in support of the USACE Hazardous, Toxic and Radioactive Waste (HTRW) Program. The laboratories will maintain this validation for all applicable methods throughout the life of the project. This validation confirms their ability to produce reliable and defensible data. Approval of the project-specific QAPP constitutes USACE approval of the selected laboratories to provide the required project-specific analyses. The analytical subcontract laboratories organizational charts, identification of key personnel and contacts, pertinent standard operating procedures (SOPs), and a copy of the laboratory's USACE validation letter(s) will be included in the project-specific QAPP.

1.1 ANALYTICAL LABORATORY PROJECT MANAGER

Each analytical subcontractor will identify a project manager (PJM) designated to act as a single point of contact at the laboratory and coordinate project details with the Jacobs' Project Chemist and Program Manager (PM). The analytical subcontractor PJM will report directly to Jacobs Project Chemist, and will be responsible for preparing the Project Technical Profile that summarizes the QA/QC requirements for the program. The analytical subcontractor PJM will be responsible for implementing the requirements of this QAPP, by providing orientation and necessary training to the appropriate laboratory personnel. The analytical subcontractor PJM will maintain the laboratory schedule and ensure that laboratory personnel follow project technical requirements.

The laboratory PJM serves as a liaison between field and laboratory operations and is responsible for the following:

- Receipt of sample custody from the field team members, verification of sample integrity, and transfer of sample fractions to the appropriate analytical departments
- Coordination of sample analyses to meet project objectives
- Preparation of analytical reports
- Review of laboratory data for compliance with USACE and method requirements
- Review of QC deficiencies reported by the analytical department managers and notification of the Jacob's Project Chemist of any deficiencies or changes that may impact the data quality.
- Coordination of any data changes resulting from review by the project QA supervisor or the PM
- Response to questions from the project team during the data quality evaluation process.

1.2 ANALYTICAL LABORATORY QA/QC DIRECTOR

The designated analytical subcontractor's QA/QC Director will have the full-time responsibility to evaluate the adherence to policies and to ensure that systems are in place to produce the level of data quality required for the project. The Quality Manager will maintain sufficient staff to initiate and oversee audits and corrective action procedures, perform data review, and maintain documentation of training. The Quality Manager will assist the PM in implementing the project-specific and USACE QA/QC requirements. Additionally, the Quality Manager has the authority to stop work on projects if QC problems arise that affect the quality of data produced.

1.3 ANALYTICAL LABORATORY TECHNICAL MANAGERS

The analytical subcontractor Technical Managers, or the organics and inorganics Group Supervisors will be responsible for ensuring that the laboratory personnel are adequately trained to perform analyses, that equipment and instrumentation are calibrated and functioning properly, and that system and performance audits are performed on an as-needed basis. The analytical subcontractor Technical Managers will coordinate these activities with the Project Manager and QA/QC Director.

2.0 DATA ASSESSMENT ORGANIZATION AND RESPONSIBILITIES

Per the USACE requirements, QA (split) samples will be collected at a frequency of 10% of the primary samples and submitted to an independent laboratory for analysis. Accordingly, two distinct data types will be generated, primary data and QA data. The data assessment of each data type is detailed in the following sections.

2.1 PRIMARY SAMPLE DATA ASSESSMENT

Review of all primary analytical data generated in association with this program will be conducted incrementally on each Laboratory Data Package (LDP). Analytical results will be thoroughly reviewed by the analytical subcontractor to ensure correctness and completeness of 100% of the results prior to release of the data. The Jacobs Project Chemist will perform data verification of the primary data for each LDP and assign qualifiers per the guidance of the USEPA Contract Laboratory Program (CLP) National Functional Guidelines (NFG) for Organic Data Review (October 1999), and the USEPA CLP NFG for inorganic data review (February 1994).

There are three steps for review of the primary data to achieve acceptable data for the purposes of this project. These steps are defined below.

Step 1 – Laboratory Data Review

The analytical subcontractors will review their data before releasing data packages/reports to Jacobs. This step is applicable to all sample analyses and will follow the process as described in Section 8.1 of this QAPP.

Step 2 – Data Verification

The Jacobs Project Chemist will be responsible for completing the data verification and assessment. Data verification is the process of evaluating the completeness, consistency, and compliance of a data package against the QAPP requirements and the project data quality objectives (DQOs). This process requires a definitive data package. The data verification process will include evaluation of the laboratory QC data indicators including: review of sample receipt conditions, holding time compliance, calibration data, results of the laboratory control sample (LCS), the matrix spike/matrix spike duplicate (MS/MSD), results of surrogate and internal standard recoveries, blank results, and results of duplicates. Jacobs will perform verification of 100 percent primary sample results with respect to these QC indicators. The procedure Jacobs will use to complete this process is described in Section 8.2.3 of this QAPP. Jacobs will assign and/or change qualifiers assigned by the laboratory to match the findings of the data assessment, without recalculating the positive hits in the data. Complete data tables and a summary of the verified analytical results will be provided in a final Chemical Data Quality Report (CDQR) to be submitted to USACE.

Step 3 – Third Party Data Validation

When deemed necessary by the USACE, Jacobs will be responsible for procuring an independent third-party validation firm to validate ten percent of the primary data. Data validation will be conducted in accordance with the guidance of the USEPA CLP NFG for Organic Data Review (October 1999), and the USEPA CLP NFG for inorganic data review (February 1994). The third party data validation will include a comprehensive review of 10% of the data including raw data, all manual integrations, and result recalculation. The third-party validation firm will be required to complete a report summarizing all findings and qualification of the data reviewed.

2.2 QA SAMPLE DATA ASSESSMENT

The QA sample data will be evaluated and compared to the associated primary sample results by an independent USACE qualified firm procured by Jacobs. The analytical subcontractor performing the QA analyses will report the QA sample results directly to the independent firm performing the QA data evaluation. The QA analytical subcontractor will be responsible for the same internal data review procedures as the primary laboratory, detailed in Section 8.1 of this QAPP, for 100% of the QA data prior to submittal to the QA evaluation subcontractor. Jacobs will be responsible for providing the primary data to the QA evaluation firm for comparison to the QA data. The results of the QA data review and evaluation against the primary results will be documented in a Chemical Quality Assurance Report (CQAR) prepared by the independent review firm. The data assessment and CQAR will be prepared per the requirements of USACE-HTRX-CX, EM-200-1-6 *Chemical Quality Assurance for HTRX Projects*, October 1997.

3.0 DATA QUALITY OBJECTIVES

The data quality objective (DQO) process is a series of planning steps based on the scientific method that is designed to ensure that the type, quality, and quantity of environmental data used in decision-making are appropriate for the intended application. DQOs are qualitative and quantitative statements derived from outputs of each step of the DQO process that:

- Clarify the study objective
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions from which to collect the data.

The DQOs are then used to develop a scientific and resource-effective sampling design.

The DQO process allows decision makers to define their data requirements and acceptable levels of uncertainty for each decision during the planning stage before data are collected. DQOs will be evaluated for this project using the seven-step process described in *Data Quality Objectives Process for Hazardous Waste Site Investigations, Final*, January 2000, (EPA, QA/G-4HW) and the specific DQOs included in each of the project-specific QAPPs. In accordance with the project DQOs, analytical methods will be selected based on their sensitivity with respect to the corresponding project sensitivity objectives.

3.1 DATA USE BACKGROUND

The project-specific QAPPs for this program will outline the historical data available for use from previous investigations and the specific data needs identified for each project. The specific data needs will be used to develop an appropriate analytical strategy for each project. The sample matrices, analytical methodology, chemical parameters, and data types (definitive versus screening) will be discussed in detail in this section of each of the project-specific QAPPs.

3.2 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this program is to develop and implement procedures for field sampling, chain-of-custody (COC), laboratory analysis, and reporting that will provide results that are legally defensible in a court of law. Specific procedures for custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventative maintenance of instrumentation, and corrective action are described in other sections of this QAPP.

Analytical support for this program may require the collection of both screening-level and definitive data. Screening-level data collected during the investigative activities may include soil headspace volatile organic compound (VOC) measurements using a photoionization detector (PID) and water quality parameters collected during groundwater sampling. Definitive data are produced from EPA-approved methods (i.e., SW-846) that provide tangible raw data (e.g., chromatograms, spectra) according to the QA/QC requirements of this document. Definitive data is defined in *Data Quality Objectives Process for Superfund*, EPA540-R-93-071, U.S. EPA Office of Emergency and Remedial Response, September 1993, as follows:

"Definitive data are generated using rigorous analytical methods, such as approved EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of

paper printouts or computer-generated electronic files. Data may be generated at the site or at an offsite location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined."

Two levels of definitive data, critical and noncritical, will be used during the execution of this work based on the intended use of the resulting data. Critical samples are those that will be used to make risk-based decisions (i.e., comparison to project screening objectives). The data for noncritical samples will be used for waste classification, permitting, evaluating treatment alternatives, or other non risk-based decisions. The three types of samples that will be collected for definitive data analysis include:

- Investigation-derived wastes (IDW) characterization (waste profile) samples (noncritical samples)
- Solid (soil/sediment) remedial investigation (RI) samples (critical samples)
- Aqueous (groundwater/surface water) remedial investigation samples (critical samples)

IDW characterization sample analyses will be supported by use of approved SW-846 analytical methods and internal laboratory QA/QC requirements. The analytical data will be provided on standardized data reporting forms indicating the sample number, the analytical method performed, the data analyzed, and the analytical results. No field QC samples will be required for noncritical samples.

Soil and groundwater remedial investigation sample analyses will be supported by use of approved SW-846 analytical methods, comprehensive laboratory data packages (LDPs), inclusion of the appropriate type and frequency of field QC samples, and 100 percent data quality assessment by Jacobs for compliance and completeness. Third-party validation may be performed at the discretion of the USACE on 10 percent of the data for the solid and aqueous investigation samples. Sufficient field and laboratory QA/QC samples will be analyzed and reported to evaluate both total measurement and analytical error. Laboratory data reporting requirements are described in Section 7.2 of this QAPP. Laboratory internal QA/QC requirements are described in Section 5.4 of this QAPP.

3.2.1 Sensitivity

The sensitivity requirement for each analyte will be based on the project screening criteria for each sample media. The project screening criteria, laboratory method reporting limits (MRLs), and method detection limits (MDLs) will be detailed in tables in the project-specific QAPPs. These tables will provide the sensitivity requirements (project objectives) for each sample matrix and parameter of interest for the analytical methods for the specific project. These tables in the project-specific QAPP will include the actual analytical subcontractors MRLs and MDLs compared to the project screening criteria for each chemical parameter of interest.

Although analytical methods will be selected to provide the highest sensitivity for the parameters in each matrix using standard procedures, some laboratory MRLs and MDLs will inevitably be above risk based screening criteria and will be shaded in the tables to designate them as such. These nonconformances are due to the fact that the sensitivity goals were developed in accordance with risk-based calculations without regard to the constraints of current analytical technology. As part of the DQO development for each specific project, the screening criteria will be compared to the available SW-846 methods to select the methods that are best suited too meet as many of the goals as possible. In addition method modifications will be evaluated as appropriate.

3.2.2 Precision

Precision is the degree of agreement among repeated measurements of the same characteristic (analyte, parameter, etc.) under the same or similar conditions. Precision data indicate how consistent and reproducible the field sampling or analytical procedures are. Comparing field and laboratory precision will help to identify sources of imprecision if a problem exists.

3.2.2.1 Field QC Sample Precision Objectives

Field precision is assessed through the collection and measurement of field duplicates (QC samples). Field duplicates will be collected and analyzed for all site project samples at a rate of one field duplicate per 10 analytical samples. The total number environmental samples, field duplicates, and other QA/QC samples anticipated for each project will be presented in tables in the project-specific QAPP.

Field QC sample precision control limits will be set at a Relative Percent Difference (RPD) of 50 for soils and an RPD of 40 for waters. In the special case where one or both results are less than five times the MRL, the criterion for soils will be the difference of three times the MRL and for waters will be the difference of two times the MRL. For chemical parameters that do not allow homogenization prior to sample acquisition (e.g., VOCs), the precision objective will be set at a RPD of 100% for soils and 50% for waters.

3.2.2.2 Laboratory Precision Objectives

Precision in the laboratory will be assessed through the calculation of RPD and relative standard deviation for three or more samples. The equation for calculating precision for this project is provided in Section 6.3.2 of this QAPP. Laboratory precision control limits are defined for most methods in Table 3-1 of this QAPP. The project-specific QAPPs may append or change these requirements based on the specific project needs. The precision goals are based on *Requirements for the Preparation of Sampling and Analysis Plan,* USACE HTRW-CX, Appendix I, EM-200-1-3, February 2001.

3.2.3 Accuracy

Accuracy is the level of agreement between an observed value (sample result) and the accepted, or true, value of the parameter being measured. Analyte accuracy can be evaluated using different types of QC samples. For example, a standard reference material or LCS, containing a known concentration of analyte provides information as to how accurately the laboratory (analysts, equipment, reagents, etc.) can analyze for a specific analyte using a selected method. Laboratory accuracy control limits are provided in Table 3-1 of this QAPP, and are based on *Requirements for the Preparation of Sampling and Analysis Plan,* USACE HTRW-CX, Appendix I, EM-200-1-3, February 2001.

3.2.3.1 Field Accuracy Objectives

Accuracy in the field is assessed through the use of field and trip blanks and through the adherence to all sample handling, preservation, and holding times.

3.2.3.2 Laboratory Accuracy Objectives

Laboratory accuracy will be assessed through the analysis of matrix spikes/matrix spike duplicates (MS/MSD), LCS', surrogate spikes, and the determination of percent recoveries. The equation used

for calculating accuracy for this project is provided in Section 6.3.1 of this QAPP. The accuracy goals for this program are defined for most methods in Table 3-1 of this QAPP. The project-specific QAPPs may append or change these as necessary to meet specific project needs. The accuracy goals are based on *Requirements for the Preparation of Sampling and Analysis Plan,* USACE HTRW-CX, Appendix I, EM-200-1-3, and February 2001.

3.2.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the total amount of data expected to be obtained under optimal conditions.

3.2.4.1 Field Completeness Objectives

Field completeness is a measure of the amount of valid measurements obtained from all the measurements taken in a specific project. The equation for completeness is presented in Section 6.3.3 of this QAPP. The field completeness objective for this program is greater than or equal to 80 percent.

3.2.4.2 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid measurements obtained from all the laboratory measurements taken in a specific project. The equation for completeness is presented in Section 6.3.3 of this QAPP. Planning and communication among all parties involved in the process are crucial to achieve high levels of completeness. However, due to the limited number of samples planned to be collected, the possibility of sample matrix difficulties that are encountered from time to time, and the accuracy and precision limits set for the project, attaining 100 percent completeness is not realistic. Laboratory completeness for this project will be greater than or equal to 90 percent for critical samples and greater than or equal to 80 percent for non-critical samples.

3.2.5 Representativeness

Representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the environmental conditions of the site. Representativeness also reflects the ability of the sample team to collect samples and laboratory personnel to analyze the samples in such manner that the data generated accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

3.2.5.1 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 procedures for sample collection in the FSP are followed and that proper sampling techniques are utilized.

3.2.5.2 Measures to Ensure Representativeness of Laboratory Data

Representativeness of the laboratory data will be ensured by using the proper analytical procedures, meeting sample-holding times, and analyzing and assessing field duplicate samples. The sampling network will be designed to provide data representative of facility conditions. Homogenization of the samples prior to aliquoting or subsampling at the laboratory is crucial to maintaining the representativeness of the analytical data set. Samples for volatiles analysis will not be homogenized.

3.2.6 Comparability

Comparability is an expression of the confidence with which one data set can be compared with another. Comparability will be achieved by using standard techniques for sample collection and analysis. Comparability is also dependent on similar QA objectives.

3.2.6.1 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the FSP is followed and that proper sampling techniques are used.

3.2.6.2 Measures to Ensure Comparability of Laboratory Data

Planned analytical data will be comparable when similar sampling and analytical methods are used as documented in the QAPP. Comparability of the analytical data also requires the implementation of similar QA objectives.

4.0 SAMPLE RECEIPT, CUSTODY, AND HOLDING TIME REQUIREMENTS

Laboratory custody procedures for sample receiving and log-in, sample storage and numbering, tracking during sample preparation and analysis, and storage of data will be documented in SOP(s) and included in the project-specific QAPP with the other pertinent analytical SOPs. The analytical subcontract laboratories will be required to maintain the sample shipment air bills and chain of custody records, as well as the sample receipt condition reports as part of the analytical data package.

4.1 SAMPLE RECEIPT, STORAGE, AND CUSTODY

Upon receipt at the laboratory, each sample will be removed from the shipping container and the sample identification of the sample bottles will be compared to the information contained on the COC documents. A sample receipt condition report will be completed for each batch of samples received. The sample condition report will document the condition of the samples (i.e., temperature, custody seals, sample identification, etc.) and note any discrepancies with the COC. If discrepancies exist, appropriate notes (signed and dated) will be made on a sample receipt condition report form; a non-conformance will be initiated and forwarded immediately to the Project Manager for review and notification of the Jacobs Project Chemist.

Upon receipt of samples, at a minimum, the following items will be confirmed and checked against the COC forms:

- The seals and tapes on the sample containers and cooler are unbroken and uncut.
- The sample containers in the cooler are intact and temperature of samples required to be preserved by cooling is within acceptable limits.
- The identification on the sample bottles corresponds to the entries on accompanying forms.
- The number of sample containers received (i.e., bottles) is equal to the number of samples listed on the COC record or accompanying forms.
- Appropriate sample containers, volumes, and preservatives were used for the analyses requested.

Unique sample identification numbers will be assigned to each sample container as part of the sample log-in process. The unique laboratory identification number will be placed on each container prior to storage and analysis. The laboratory identification number will be used to track the storage and transfer of the sample custody within the laboratory. Proper custody and cold storage (for samples requiring temperature preservation) must be maintained and documented for samples throughout the analytical process. Samples will be returned to the appropriate storage area after analysis for storage with temperature preservation and custody maintained in case re-analysis is required.

Custody is one of several factors necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for 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, will be maintained under document control in a secure area.

A sample is under an individual's custody if:

- The item is in actual possession of a person
- The item is in the view of the person after being in actual possession of the person
- The item was in actual physical possession but is locked up to prevent tampering
- The item is in a designated and identified secure area.

Samples may not be shipped or subcontracted to another analytical facility without prior permission or approval of the Jacobs Project Chemist or Program Manager (and the USACE PM). If samples are permitted to be shipped to another USACE HTRW-CX approved facility, the custody and temperature preservation must be maintained, documented, and provided as part of the final data deliverable.

4.2 HOLDING TIME REQUIREMENTS

The holding time is defined as the time allowed to elapse prior to the completion of a step in the analytical process or the analysis itself. The USEPA SW-846 method holding times will be listed in the project-specific QAPPs for all appropriate analytical methods. Some of the methods have multiple holding times for preservation, extraction, and analysis. Holding time compliance for each analysis step is essential in maintaining the representativeness of the data set. The holding time for a sample is tracked from the time and date of sample collection through the completion of the analysis or extraction step. The analytical subcontractor will provide result forms, sequence logs, and/or QC batch forms that include the dates and times for each sample preparation and analysis. The data verification and validation steps will include an evaluation of sample holding time compliance.

The field sampling team is obligated to ship samples via overnight courier as soon as possible after sample collection to allow for adequate time for the analytical subcontractor to comply with the method holding times. The analytical subcontractor will meet all method required holding times. Failure to meet the method holding times may result in invalidation of the sample results and could result in non-payment for the analytical results. Sample preparation and analysis should be planned and executed so that adequate time is available for re-preparation and/or re-analysis within the holding times of samples due to QC deficiencies. Violation of a sample holding time must be reported to the Jacobs Project Chemist or Project Manager immediately upon discovery so that an informed decision to resample or proceed with the analysis may be reached by Jacobs and the USACE.

5.0 ANALYTICAL PROCEDURES

The analytical subcontractors selected to support this program will implement method specific laboratory SOPs for sample preparation, cleanup and analysis for each method required by the project-specific QAPPs. These laboratory SOPs are based on methods from SW-846 Final Update III, Revision 4 (December 1996). The specific laboratory procedures required for each project for this program will be included as an Appendix to the project-specific QAPPs. This section of the project-specific QAPPs will detail the analytical methodology required for each sample matrix for the specific project.

5.1 LIST OF METHODS, TARGET COMPOUNDS AND LABORATORY QUANTITATION LIMITS

A complete listing of chemical parameters of concern by analytical method, and the subcontract analytical laboratory determined MDLs and MRLs for each parameter of concern will be detailed in tables included in the project-specific QAPP. MDLs shown in these tables will be experimentally determined using the method found in 40 Code of Federal Regulations (CFR), Part 136. MRLs will be based on a value that is equal to or greater than the lowest calibration standard used in initial calibration for each method. MRLs should be more than or equal to 3 times the MDL. The analytical laboratories will report detected values less than the MRL but greater than the MDL as estimated values, and qualify them as "J".

5.2 LABORATORY INSTRUMENT PREVENTATIVE MAINTENANCE

As part of their QA/QC Programs, routine preventative maintenance programs will be conducted by the analytical subcontractor(s) to minimize the occurrence of instrument failure and other system malfunctions. The laboratory analysts will perform routine scheduled maintenance, and repair or coordinate with the vendor for the repair of all instruments. All laboratory instruments will be maintained in accordance with manufacturers' specifications and the requirements of the specific method employed. This maintenance will be carried out on a regular, scheduled basis, and documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturers' maintenance will be provided under a repair and maintenance contract with factory representatives. Table 5-1 of this QAPP summarizes the laboratory instrument minimum preventative maintenance activities.

5.3 LABORATORY INSTRUMENT CALIBRATION PROCEDURES AND FREQUENCY

All measuring and test equipment (M&TE) will be calibrated against certified equipment and/or standards with valid traceability to nationally recognized standards. M&TE will be calibrated, adjusted, and maintained at prescribed intervals and/or before use. All standards used for equipment calibration will be traceable to the EPA, National Institute of Standards and Technology (NIST), or a commercially available certified standard. The source of the standard used must be documented in a calibration logbook.

Calibration procedures for laboratory instruments will be in accordance with the appropriate SW-846 methods as defined in the following text and the selected analytical subcontractor(s) SOPs. A table will be included in the project-specific QAPPs providing a cross-reference of project-required analytical methods to laboratory SOP numbers for each anticipated analyte group. The laboratory SOPs will be included as an Appendix to the project-specific QAPPs.

The SOP for each analysis performed in the laboratory will describe the calibration procedures, calibration frequency, acceptance criteria, and the conditions that will require recalibration. In all

cases, the initial calibration will be verified using an independently prepared (second source) calibration verification solution. The laboratory will maintain a sample logbook for each instrument that will contain the following information: instrument identification, date of calibration, analyst, and calibration solutions run and the samples associated with these calibrations.

Calibration of laboratory equipment will be based on these 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 all 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 include the following:

- Each set of data will have an associated traceability to calibration via the instrument logbook or instrument processing software (i.e., Envision, Target).
- A written stepwise calibration procedure will be available for each piece of test and measurement equipment.
- Any instrument that is not calibrated to within the manufacturer's original specification will display a warning tag (e.g. "Out of Service") to alert the analyst that the device is not properly calibrated and not acceptable for use with sample analysis.

5.3.1 Organic Analyses

Before calibration, GC/MS instrumentation will be tuned by analysis of p-bromofluorobenzene for volatile analyses and decafluorotriphenylphosphine for semivolatile analyses. Once the tuning criteria for these reference compounds are met, the instrument will be initially calibrated by using a five-point calibration curve. The instrument tune will be verified each 12 hours of operation prior to sample analysis.

GC and HPLC instrumentation will be initially calibrated using a five-point calibration curve. Continuing calibration will be verified as specified in the SOP, or at least each working day, using criteria specified by the method. The calibration standards will be USEPA- or NIST-traceable and will be spiked with internal standards and surrogate compounds.

5.3.2 Metals Analysis

The Atomic Absorption Spectrophotometer, Cold Vapor Atomic Absorption, and Inductively Coupled Plasma (ICP) Emission Spectrophotometer instruments will be calibrated by use of a minimum of three calibration standards prepared by dilution of certified stock solutions. An analysis blank will be prepared with one calibration standard at the reporting 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, will be prepared and analyzed after each 10 samples and at the end of the sequence. The value of the continuing calibration standard concentration must agree with +/- 10 percent of the initial value or the appropriate corrective action is taken that may include recalibrating the instrument and reanalyzing the previous 10 samples.

5.4 QUALITY CONTROL REQUIREMENTS

5.4.1 Field Sampling Quality Control

QC procedures for the water quality meters will include calibrating the instruments as described in the manufacturers operating procedures at least daily before use. Assessment of field sampling precision and bias for critical sample collection will be made by evaluation of field duplicate sample data. Collection of field QC samples will be in accordance with the frequencies indicated below and summarized in tables in the project-specific QAPPs.

5.4.1.1 Trip Blanks

Trip blanks consisting of deionized water, will be submitted to the analytical laboratory to provide the means to assess the quality of the data resulting from the sampling program. Trip blanks will be used to assess the potential for contamination of samples due to contamination migration during sample shipping and storage. Trip blanks will pertain to VOC samples only. Trip blanks will be prepared by the analytical laboratory before the sampling event. The trip blanks will be shipped to the site in the same coolers as the VOC sampling containers. The trip blanks will be kept in their original sample container with the investigative samples throughout the sampling event. They will be packaged for shipment with other samples and sent for analysis. There will be one trip blank included in each sample shipping container containing VOC samples. At no time after their preparation by the laboratory will the trip blank sample containers be opened before they are returned to the laboratory for analysis.

5.4.1.2 Field Duplicates

Field duplicate samples will be analyzed to check for sampling and analytical reproducibility and are used in the assessment of total precision. The field duplicate samples will be collected as split samples from the same location as their corresponding primary sample. Care will be taken to ensure that both the primary and field duplicate samples are representative of the same material being sampled. For VOC soil samples, the field duplicate will be collected from an offset of the original sample location. The field duplicate samples will be numbered differently from their primary sample, as discussed in Section 6.3.1 of the FSP, but will be handled and shipped with their corresponding primary sample. Field duplicate samples will be required at a frequency of one per ten environmental samples.

5.4.1.3 Equipment Rinsates

Equipment rinsates will be used to verify that decontamination procedures for field sampling equipment are effectively removing all potential site contaminants. The equipment rinsate is a sample of American Society for Testing and Materials (ASTM) type II reagent grade water poured into or over or pumped through an environmental sampling device. Equipment rinsates will be collected at a frequency of one per group of 10 or fewer aqueous investigative samples. Equipment rinsates will also be required for soil sampling equipment if dedicated or new equipment is not used. The equipment rinsates will be analyzed for the same analytical methods as the associated field samples.

The specific type and frequency of field QC samples to be collected for this program will be specified in tables in the project-specific QAPP. Sampling locations and the rationale for the locations and analyses will be specified in the project-specific FSPs. The locations for the QC samples will be at the Site Managers (SM) discretion. It is also the SMs responsibility to ensure the required frequency for QC samples as established in this QAPP are fulfilled.

5.4.2 Analytical Quality Assurance/Quality Control

5.4.2.1 QA Laboratory

Samples that are split from primary or duplicate samples are called QA samples. QA samples will be analyzed by the QA Laboratory, a second independent HTRW-CX certified laboratory. QA samples will be collected at a frequency of one per 10 field samples and sent to the QA laboratory for analysis of the same analytical suite as the primary field investigative samples. The QA laboratory will be bound to the same level of quality control as the primary laboratory detailed in the following sections of this QAPP.

For this program it is the responsibility of Jacobs to designate and procure the services of an independent qualified laboratory to perform the QA analyses. QA sample collection and analysis is the main tool to determine that the data generated by the primary analytical subcontractors is technically valid and of adequate quality for the intended data usage. The data generated by the QA laboratory will be provided directly to an independent validation firm contracted by Jacobs for evaluation as part of the Chemical Data Quality Assurance Report (CQAR) process.

5.4.2.2 Primary Laboratory

The primary laboratories will analyze the primary samples, which constitute 100% of the samples collected (except the QA split samples) including field QC samples. The primary laboratories must be certified HTRW approved laboratories selected by Jacobs. These laboratories are called primary or QC laboratories, and the primary sample data generated is referred to as QC data. QC data is not to be confused with the QC analyses performed by the laboratory (i.e. blanks, LCS etc.).

The subcontract analytical laboratories will be required to have QC programs in place to ensure the reliability and validity of the analysis performed. The appropriate method specific SOPs from the analytical subcontractors will be included as an appendix to the project-specific QAPP. All analytical procedures will be documented in writing as SOPs, and each SOP will include a QC section that addresses the minimum QC requirements for the procedure. These procedures include batch and matrix specific QC sample analyses. The internal QC checks differ slightly for each individual method or procedure but in general the laboratory QC requirements will include the following elements:

- Method blanks (MB)
- Instrument blanks
- Surrogates (organics only)
- MS/MSD (organics only)
- Post-digestion and analytical spikes (metals)
- MS/Laboratory Matrix Duplicate (MD) (metals only)
- LCS
- Mass tuning for GC/MS analysis
- Internal standard areas for GC/MS analysis; control limits

- Endrin/Dichlorodiphenyltrichloroethane degradation checks for pesticide analyses
- Second dissimilar column confirmation for GC and HPLC analyses
- MDL study (performed annually for each method/instrument)

The type and frequency of QC samples performed by the laboratory will be dependent upon the specified analytical method and the project DQOs. Internal QC methods require performance on a sample batch basis and include analyses of method blanks, LCS, and actual environmental samples as MDs, MSs, and MSDs.

Internal QC checks will be used to determine if analytical operations are in control, as well as determining the effect sample matrix may have on data being generated. These two aspects are described as batch QC and matrix-specific QC procedures, respectively. The type, frequency, and acceptance criteria of specific QC samples performed by the analytical subcontractor will be consistent with the specified SOPs and requirements outlined in this QAPP. The method minimum laboratory QC requirements are specified within the referenced methods, and laboratory SOPs. Acceptance criteria and/or target ranges for QC samples will be specified within tables in the project-specific QAPPs for each chemical parameter of concern. Data that vary from these target ranges will result in the implementation of appropriate corrective measures, potential application of qualifiers, and/or an assessment of the impact these corrective measures have on the usability of the data in the decision-making process. Corrective action requirements, with regards to sample analyses, are discussed in Section 5.6.3.2 of this QAPP.

5.4.3 Batch Quality Control

The analytical batch will be the basis for determination of the required frequency of laboratory internal QC check samples. An analytical batch will be defined as a preparation batch of one to 20 field samples from a similar matrix that are extracted and/or analyzed concurrently. Each analytical batch will contain a complete set of internal QC samples as discussed in the following sections. Batch QC samples will be extracted concurrently and analyzed sequentially with the associated batch of field samples.

5.4.3.1 Method Blanks (MB)

MBs will be analyzed to assess the level of background interference or contamination that exists in the analytical system and that might lead to the reporting of elevated concentration levels or false positive data. The MB is defined as a blank matrix to which all reagents are added in the same volumes or proportions as used in sample preparation and carried through the complete sample preparation and analytical procedure.

At least one MB will be analyzed with every batch of samples processed. The acceptance criterion for the MB is to be free of target analytes at the level of quantitation. Results of the MB analysis will be evaluated, in conjunction with other QC information, to determine the acceptability of the data generated for that batch of samples. In order to meet project-screening criteria, sample results will be reported down to the MDL for certain analyses. In these cases the MB must be reported down to half the MRL to allow for a consistent evaluation of the results. If the blank does not meet acceptance criteria, the source of contamination will be investigated and appropriate corrective action will be taken and documented. Investigation includes an evaluation of the data to determine the extent and effect of the contamination on the sample results. Corrective actions may include reanalysis of the blank and/or repreparation and reanalysis of the blank and all associated samples at no additional expense. Sample results will not be corrected for blank contamination.

5.4.3.2 Laboratory Control Samples (LCS)

Evaluation of laboratory performance will be based on the LCS results. LCS samples are standard control matrices that are prepared independently from the standard solutions used in establishing the calibration curve, to calculate the accuracy of the data. LCS samples will be carried through the complete sample preparation and analytical procedure, and will be compared to the control limits defined in tables in the project-specific QAPPs to determine if the analysis was performed within the acceptable range of control for each target analyte. The LCS, along with MB data, will be used to assess daily laboratory performance.

5.4.3.3 Matrix-Specific Quality Control

Matrix-specific QC is dependent on whether the analysis is for organic or inorganic constituents and will be based on the use of actual environmental samples for precision and accuracy determinations. Matrix-specific QC for organic analyses includes the analysis of surrogate compounds, MS/MSD samples. MS/MSD results provide information about the effect of sample matrix on the extraction and measurement methodology. Matrix-specific QC for inorganic analyses includes the analysis of MS, and an unspiked matrix duplicate (MD) sample, serial dilutions, and post digestion spikes. Post digestion spikes are required for Graphite Furnace Atomic Absorption work, and when the serial dilution fails for ICP work. Results of these analyses, supplemented with field blank results, will be used to assess the effect of sample matrix and field conditions on analytical data.

MS/MSD samples will be designated/collected for organic analyses only. Inorganic sample analyses will use an MS/MD.

Soil MS/MSD and MS/MD samples may require extra volume for extractable organics and inorganics analyses. The subcontract analytical laboratory will prescribe the sample volume required to analyze the soil MS/MSD samples. Typically, one additional sample volume will be collected for soil analyses. Aqueous MS/MSD and MS/MD samples must be collected at triple the volume for VOCs and extractable organics, and double the volume for inorganics. One MS/MSD pair will be collected/designated for every 20 or fewer investigative samples per sample matrix (i.e., groundwater, soil) for organics and one MS/MD pair will be collected/designated for every 20 or fewer investigative samples per sample matrix (i.e., groundwater, soil) for inorganics.

5.4.3.4 Other Laboratory QC Samples

Additional laboratory QC requirements will be detailed within the laboratory's SOPs and will be analyzed as required.

5.5 PERFORMANCE AND SYSTEM AUDITS

Technical systems and performance audits may be conducted as independent assessments of sample collection and analysis procedures. Audit results will be used to evaluate the ability of an analytical contractor to 1) produce data that fulfill the objectives established for the program, 2) comply with the QC criteria, and 3) identify any areas requiring corrective action. The systems audit is a qualitative review of the overall sampling or measurement system. Full data validation is also a quantitative check of the analytical process, where all documentation and calculations are evaluated and verified.

5.5.1 Analytical Subcontractor HTRW-CX Certification

Analytical subcontractors must have and maintain current HTRW-CX certification for each project-specified method for the duration of the project. The analytical subcontractors' HTRW-CX certifications will be included as an appendix to the project-specific QAPP. Only laboratories holding this certification will be eligible to support this program (including the QA laboratory).

5.5.2 Technical Systems Audits

A technical systems audit is an on-site, qualitative review of the sampling or analytical system to ensure that the activity is being performed in compliance with the FSP/QAPP specifications. Sampling and field procedures and the analytical laboratories may be audited by the Contractor at any time during the performance of program related work. The checklist for each audit will contain detailed questions regarding the critical items, requiring yes/no answers and comments.

Critical items for a laboratory or field systems audit include:

Sample custody procedures

Calibration procedures and documentation

Completeness of data forms, notebooks, and other reporting requirements

Data review and validation procedures

Data storage, filing, and record keeping procedures

QC procedures, tolerances, and documentation

Operating conditions of facilities and equipment

Documentation of training and maintenance activities

Systems and operations overview

Security of laboratory automated systems

Field audits will be conducted by the Program Quality Manager (QM). Laboratory audits will be conducted by, as appropriate, the Program QM, the Project Chemist, the Database Manager, or other qualified Contractor auditors.

After each on-site audit, a debriefing session will be held for all participants to discuss the preliminary audit results. The auditor will then complete the audit evaluation and submit an audit report, including observations of any deficiencies and the necessary recommendations for corrective actions. Compliance with the specifications presented in this QAPP will be noted and noncompliance or deviations will be addressed in writing by the Contractor to USACE, with corrective actions and a time frame for implementation of the corrective actions. In the event that a major defect is discovered as a result of one of these audits, a follow-up inspection will be conducted after sufficient time has passed for correction of the deficiency, or evidence of correction of the deficiency may be presented. Follow-up audits will be performed prior to completion of the project to ensure corrective actions have been taken.

5.5.3 Field System Audits

System audits of site activities may be accomplished by an inspection of all field site activities by a Contractor technical audit team. During this audit, the audit team will compare current field practices with standard procedures. All numerical manipulations (including manual calculations) will be documented. All records of numerical analyses will be legible, of reproduction quality, and sufficiently complete to permit logical reconstruction by a qualified individual other than the originator.

Critical items for a sampling systems audit include:

Calibration procedures and documentation for field equipment

Documentation in field logbooks and sampling data sheets

Organization and minimization of potential contamination sources while in the field

Proper sample collection, storage, and transportation procedures

Compliance with established COC and transfer procedures

The following elements will be evaluated during field systems audits:

- Overall level of organization and professionalism
- Level at which all activities are conducted in accordance with the Work Plan
- Level at which all procedures and analyses are conducted according to procedures outlined in this QAPP
- Level of activity and sample documentation
- Working order of instruments and equipment
- Level of QC conducted per each field team
- Contingency plans in case of equipment failure or other event preventing the planned activity from proceeding
- Decontamination procedures
- Sample packaging and shipment
- Calibration procedures and documentation for field instruments
- Documentation in field logbooks and on sampling data sheets
- Document control
- Equipment maintenance and decontamination procedures
- Sample collection, storage, and transportation procedures

- COC procedures for sample documentation and for transfer to the laboratory
- SOPs
- Corrective action system and reports
- Training

After completion of the audit, any deficiencies will be discussed with the field staff and corrections will be identified. If any of these deficiencies could affect the integrity of the samples being collected, the audit team will inform the field staff immediately so that corrections will be implemented immediately. The audit team will consist of the Program QM and the PM.

5.5.4 Laboratory Systems Audits

Laboratory systems audits are qualitative audits of the measurement systems, ensuring that they are properly maintained and used. The analytical laboratories may be audited by the Contractor at any time during the program. The laboratories are required to perform according to quality requirements of the USACE *Shell for Analytical Chemistry Requirements* EM-200-1-3, February 2001, this program QAPP, the project-specific QAPP, and the laboratory QAPP that address their own internal operations. A laboratory systems audit may also be performed by the USACE if previous audit reports indicate that corrective actions are outstanding, a recent audit has not been conducted, or quality concerns have arisen based upon the use of that laboratory for other projects. The laboratory systems audit results will be used to review laboratory operation, ensure that technical procedures and documentation are in place and operating to provide data that fulfill the project objectives, and ensure outstanding corrective actions have been addressed. A laboratory audit will include a review of the following:

- Analytical and support instrumentation maintenance logs
- Analytical and support instrumentation calibration logs
- Refrigerator and freezer temperature records
- Distilled/deionized water supply records
- Sample tracking system
- Reference material tracking system
- Reagent chemical login, tracking, and disposal.

During an on-site laboratory systems audit, laboratory records and procedures will be inspected for completeness, accuracy, precision, and adherence to prescribed methods. This inspection will include the following:

- Following the sample COC from time of sample receipt, through all analysis steps, to data reduction, validation, and report generation.
- Examining maintenance and calibration logbooks to ensure that maintenance and calibration are performed on a scheduled basis.

- Examining procedures and records for data calculation, transfer, and validation.
- Spot-checking calibration, QC, and sample data from selected instruments for selected days to ensure acceptable precision, accuracy, and completeness.
- Inspecting storage areas, glassware preparation areas, and distilled/ deionized water system.
- Examining QA procedures and records (standard and spike solution logbooks and storage areas, control charts, and QA manuals).

Other critical items for a laboratory system audit include the following:

- Calibration procedures and documentation
- Documentation and use of standards
- Completeness of data forms, notebooks, and other reporting requirements
- Data review and verification procedures
- Data storage, filing, and record keeping procedures
- Sample custody procedures
- QC procedures, control limits, and documentation
- Corrective action system and reports
- Operating conditions of facilities and equipment
- Documentation of training and maintenance activities
- Sample receipt, storage, and custody
- Sample preparation
- Sample analysis
- Documentation of standards, spikes, and solutions
- Adherence to the guidelines in this QAPP
- Training

An additional laboratory system audit may be performed by spot-checking analytical data from the laboratory. These data will include all methods specified in the project-specific QAPP. During the time that analytical activities are underway, the laboratory may be requested to send the Program QM raw laboratory data for a fraction of the samples under analysis. These raw data will be reviewed for completeness, accuracy, precision, technical competence, and adherence to method specifications. Any deficiencies identified during this data review will be addressed immediately with the Laboratory PM and the Contractor PM, and corrective action will be taken.

5.5.5 Laboratory Performance Audit

The laboratory performance audit will occur over the entire sample collection and analysis event. Critical items will be evaluated and addressed by Contractor's Project Chemists. Critical items include performance evaluation (PE) samples, field and laboratory duplicates, field and laboratory blanks, surrogates, MSs, internal standards, instrument calibration, and laboratory documentation. The performance of the laboratory will also be determined by the qualification of the data during data validation.

5.5.6 Performance Evaluation Sample Programs

All laboratories will demonstrate competence by participating in the USEPA PE Water Supply and Water Pollution Studies programs (or equivalent programs) for state certifications. Satisfactory performance in these nonproject-specific PE programs also demonstrates proficiency in methods used to analyze USACE samples. The laboratory will document the corrective actions to unacceptable PE results to demonstrate resolution of the problems.

5.6 NONCONFORMANCES AND CORRECTIVE ACTIONS

When a significant condition adverse to quality is noted at the project site, laboratory, or other subcontractor locations, the significance of the condition will be determined and appropriate reportability will be undertaken. A condition adverse to quality is an inclusive term used in reference to any of the following: failures, malfunction, deficiencies, defective items, and nonconformance. Nonconforming condition identification, probable cause, required documentation, the corrective action, and root cause will be reported to the Contractor PM, Program QM, Field Team Leader, and involved subcontractor management, at a minimum. Corrective action for either field or laboratory operations includes response, re-establishment of control, and documentation. Implementation of corrective action will be independently verified by the Program QM. All project personnel have the responsibility, as part of their normal work duties, to promptly identify, solicit approved correction, and report conditions adverse to quality.

5.6.1 Nonconformances

It is the responsibility of the individual who first recognizes a deficiency to identify and document the nonconformance using a nonconformance report (NCR). The individual who suspects nonconformance to previously established criteria or protocol in equipment, instruments, data, or methods will immediately notify his/her supervisor.

A Nonconformance Log will be maintained by the Program QM and a copy of completed log sheets will be submitted to the project file. Following appropriate reporting, the Program QM and PM will determine whether the reported item or service is nonconforming and its nonconformance priority. They may decide that a Stop Work Order is justified and indicate if further reporting is necessary (i.e., corrective action reporting, which is discussed in the following subsection). A statement of disposition and the identification of probable cause will be documented by the responsible individual's organization and actions to prevent recurrence will be specified. Verification and closure will be accomplished when the completed actions are determined to be satisfactory by the Project QM and PM.

5.6.2 Corrective Action Report

The Project QM and PM will determine whether immediate corrective measures are needed to prevent loss to the program. The PM must concur in situations that warrant stopping work. If it is

determined that a deficiency is significant such that a Corrective Action Report (CAR) is required, a CAR will be prepared by the Program QM.

CARs will be analyzed for trends by the Project QM. Long-term corrective action procedures may be devised and implemented to prevent the recurrence of a potentially serious problem. An investigation to determine the severity and extent of the problem will be conducted by the Project QM and a CAR will be filed with the PM. In the case of a dispute, the Project QM will make the final determination. If corrective action will impact the project budget or schedule, the action requires involvement of the USACE PM. For problems detected in field or laboratory audits, the auditor, the field or Laboratory QA Officer, the Project QM, or the PM will document all notifications, recommendations, and the final decision. The PM will notify program staff and implement the agreed-upon course of action. The Project QM will verify the efficacy of the implemented actions. The development and implementation of preventive and corrective actions will be timed, to the extent possible, to not adversely impact either project schedules or subsequent data generation/processing activities. The Project QM will also be responsible for developing and implementing routine program controls to minimize the need for corrective action.

5.6.3 Corrective Action System

Project management and staff, including field investigation teams, QA auditors, document and sample control personnel, and laboratory groups will monitor ongoing work performance in the normal course of their daily responsibilities. Events that require corrective action include the following:

- Violation of established field procedures
- Violation of established analytical controls
- Results of performance, system, or project QA audits

Corrective action may take several forms, but the following steps are almost always included:

- Check the calculations.
- Check the instrument for proper setup.
- Re-analyze the control item and the associated samples.

The corrective action may be immediate or long-term. A corrective action requiring immediate response may be recalculation, re-analysis, or repeating sample collection. Immediate corrective action is usually applied to spontaneous, non-recurring problems. Instrument and equipment malfunctions and non-conforming field procedures are amenable to this type of action. Long-term corrective action may be identified through, but not be limited to, PE samples, standards, and control charts.

Depending on the nature of the problem, the corrective action employed may be formal or informal. In either case, occurrence of the problem, corrective action employed, and verification that the problem has been eliminated will be documented. Corrective actions may be initiated as a result of the following circumstances, at a minimum:

- When predetermined acceptance standards are not met (objectives for precision, accuracy, and completeness), including criteria for laboratory and field measurement methods established in this QAPP.

- When procedures or data compiled are determined to be incorrect.

- When equipment or instrumentation are determined to have been incorrectly operated or maintained.

- When the custody of samples and analytical results cannot be traced with certainty.

- When QA or QC requirements have not been achieved.

- When designated approvals have not been obtained.

- As a result of unsatisfactory laboratory or interlaboratory comparison studies, audits, or PE results.

Corrective action logs will be reviewed regularly to discover if patterns exist. Trend analysis will identify problems whose root causes will be determined and eliminated.

5.6.3.1 Field Corrective Action

To understand when corrective action is required in the field, the difference between a variance and a nonconformance must be defined. A variance is a project change that may improve the quality but would not significantly decrease the quality of the data generated or change the rationale of the field procedures and sampling locations. An example of a variance would be changing the size of the split-spoon sampler used. All variances must be recorded by the Field Team Leader on a Variance Request Form and in the appropriate field logbook.

A nonconformance is an occurrence that may be a direct result of an error, deficiency, or out-of-control situation. A nonconformance may also be defined as a necessary change in regulations, approved requirements, or procedures. Nonconformances may have an adverse effect on quality, health and safety, durability, performance, or any other basic objective impacting the quality of work performed. All nonconformances must be documented on a NCR. Examples of situations requiring corrective action encountered in the field include the following:

- Changing the well or soil sampling procedures due to drilling equipment concerns

- Unexpected contamination in field blanks

- Calibration problems with field equipment

- Field screening equipment failure

- Any field condition that might become a health and safety issue.

The initial responsibility for monitoring the quality of field measurements lies with the field personnel. The Site Manager is responsible for verifying that QA procedures are being followed and for directing immediate corrections, as necessary. If a problem occurs that might jeopardize the integrity of the project, cause a QA objective not to be met, or affect data quality, the Site Manager will immediately notify the PM and Project QM, if appropriate. Corrective action measures will be

formulated and implemented. The client may be notified as well. The Site Manager will document the situation, the field objective affected, the corrective action taken, and the results of that action. Copies of the documentation will be provided to the PM and the Project QM.

5.6.3.2 Laboratory Corrective Action

Corrective action may be required due to the following laboratory situations: equipment malfunction, failure of internal QC checks, method blank contamination, failure of performance or system audits, and noncompliance with QA requirements.

When measurement equipment or analytical methods fail to meet QC requirements, the problem will immediately be brought to the attention of the Laboratory QA Officer. If failure results from equipment malfunction, the equipment will be repaired and recalibrated and the analysis will be rerun. All attempts will be made to reanalyze all affected parts of the analysis so that the results are not affected by failure to meet QC requirements. Where this is not possible, data reported will be qualified as required in this QAPP with a note as to the reason for the qualification. All incidents of failure to meet QC requirements, and the corrective action taken, will be documented. CARs will be placed in the appropriate project file. In addition, the bench chemist will be responsible for ongoing monitoring of the system(s) affected to ensure that any recurring problems are identified immediately. Corrective action will be prompt for deficiencies noted during the check of raw data. This action will vary depending upon the problems noted, and can range from correcting miscalculated data to requiring the reanalysis of samples. After corrective actions are implemented, evidence of correction of the deficiency will be presented. Documentation of the corrective action measure will be forwarded to the Contractor Project QM and Project Chemist.

Laboratory corrective actions will be tracked (using a log), to verify that nonconformances are addressed promptly and corrective actions closed. The log will be examined periodically for patterns or trends requiring attention. Root causes of nonconformances and trends will be determined and the causes eliminated.

Corrective action documentation will include the following information:

- Nature of the problem
- Date and time of discovery
- Analytical parameter affected
- Sample(s) and lot(s) affected
- Date, time, and description of the resulting corrective action
- Signature of the Laboratory QA Officer

5.7 QUALITY ASSURANCE REPORTS TO MANAGEMENT

At a minimum, the Project QM will prepare a quarterly summary report that describes the status of the project, QA/QC problems, corrective actions taken, and unresolved CARs with recommended solutions for management. The report will also include results from all PE samples, audit findings, and periodic data quality assessments. This report will be available for review by the USACE auditors upon request.

5.7.1 Field Quality Assurance Reports

The mobilization stage will be audited by the PM before work begins to ensure that all field personnel have been provided with the necessary procedures, training, and materials to conduct the field sampling activities according to the Work Plan, which includes the FSP and this QAPP. Field activities will be audited once to ensure compliance with the procedures described in this document. Any other audits and all corrective actions will be reported in writing to the PM.

The PM will submit monthly status reports to the client describing the progress of the project. To support this requirement, the Field Team Leader will provide the Project Manager with daily field progress reports, compiled field data sets, and corrective action documentation at appropriate intervals.

5.7.2 Laboratory Quality Assurance Reports

A project QA report that summarizes all QA activities and QC data for the Plumbrook Site will be issued when analysis data are reported to the PM. In addition, the Laboratory PM will provide QA update memoranda (i.e., copies of all field custody forms received and laboratory sample status and custody forms generated) for each sampling episode to the Project QM and PM upon evaluation of the analytical work for that episode. Laboratory narrative reports will discuss the results of internal performance and system audits, nonconformances and corrective actions, and proposed method or laboratory QAPP changes. Monthly QA reports from the laboratory will summarize these topics.

The Project Chemist and PM will be notified immediately of laboratory QA situations (e.g., exceeded holding times, unacceptable surrogate recoveries, and inadequate sample volume) requiring immediate corrective action (i.e., recollecting samples). The sample custodian will note all situations that may affect laboratory and project QA objectives on the COC form or a sample receipt log and return a copy to the PM.

5.7.3 Quality Assurance Reports To Client

The Contractor PM will provide regular progress reports to the client, to include the following:

- Project name and contract number
- Summary information from Site Manager and laboratory progress reports
- Description of progress against schedule: sampling locations completed, analyses completed, verification completed, and percentage remaining
- Descriptions of and justifications for any significant revisions to the Work Plan
- Field change requests, justifications, and disposition
- Results of performance and system audits, data quality assessments, and significant QA proposed corrective actions
- Summary of all out-of-control events (field and laboratory) during the monthly reporting periods, including references to documentation, significant QA proposed corrective actions, and CARs; discussion of samples and locations affected, and the impact on the project activities and schedule

- Changes in the Contractor's personnel and other key technical staff, including resumes of new personnel.

- The Contractor's internal quality reports will be issued that address subcontractor performance, QA audit statistics and results, independent technical review issues, and the Contractor's internal and external project performance measurement system.

6.0 DATA REDUCTION/CALCULATION OF DATA QUALITY INDICATORS

6.1 FIELD DATA REDUCTION PROCEDURES

Field data reduction procedures will be minimal in scope compared to those implemented in the laboratory setting. Only direct reading instrumentation will be employed in the field. The use of PIDs, water level meters, pressure transducers, and water quality meters will generate measurements directly read from the meters following calibration per manufacturer's recommendations. Such data will be recorded in field logbooks 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.

Because the use of field instrumentation such as a mobile GC will not be used, there will be no further need for assuring that field data has been reduced properly through the use of formulas or interpretation of raw data printouts.

6.2 LABORATORY DATA REDUCTION PROCEDURES

For this project, the equations that will be employed in reducing data will be specified in the laboratory SOPs for inorganic and organic analyses. Laboratory data reduction procedures will be followed according to the following protocol: all raw analytical data will be recorded in numerically identified laboratory logbooks. Only the QA department will issue these logbooks. Data will be recorded in these logbooks along with other pertinent information, such as the sample identification numbers and the sample label numbers. Other details will also be recorded, such as the analytical methods used, names of analysts, the dates of analysis, instrument settings, and the raw data. Each page of the logbook will be signed and dated by the analysts. Copies of the instrument printouts (such as gas chromatograms) will be submitted as part of the data package. Periodic review of these logbooks by the department personnel takes place before final data reporting.

Specific data reduction procedures will be summarized within the analytical subcontractor's SOPs along with the persons responsible for each task. These procedures address any calculations used for reducing data.

In general, data will be reduced in one of the following ways:

- Manual computation of results directly on the laboratory bench sheet or on calculation pages attached to the data sheets
- Input of raw data for computer processing
- Direct acquisition and processing of raw data by a computer.

If data are manually processed by an analyst (i.e., manually integrated), all steps in the computation are provided including the equations used and the source of input parameters such as response factors, dilution factors, and calibration constants. If calculations are not performed directly on the data sheet, calculations are done on standard calculation paper and attached to the data sheets. All data that is manually integrated will be qualified with an "M" flag in the laboratory data reports and discussed in the laboratory case narratives.

If data are input and processed using a computer, a copy of the input is kept and uniquely identified with the project number and other information, as needed. The samples analyzed will be evident and the input signed and dated by the analyst.

If data are directly acquired from instrumentation and processed, the analyst verifies that the following are correct: project and sample numbers, calibration constants and response factors, output parameters such as units, and numerical values used for MRL (if a value is reported as less than). The review analyst signs and dates the resulting output.

6.3 USABILITY RECONCILIATION WITH DATA QUALITY OBJECTIVES

6.3.1 Accuracy Assessment

Analytical accuracy will be assessed through the use of known QC and fortified samples and will be presented as a percent recovery. Accuracy will be calculated as follows:

$$PERCENT\ RECOVERY = \frac{(C_2 - C_1)}{C_0} x100\%$$

where: C_2 = measured value of the spiked sample,

C_1 = measured value of the unspiked sample,

C_0 = known amount of the spike in the sample.

Accuracy will be evaluated through the analysis of MS/MSD samples, LCS, and by spiking samples with surrogate compounds for organic analyses.

To assure the accuracy of the analytical procedures, an environmental sample will be randomly selected from each sample shipment received at the laboratory, and spiked with a known amount of the analyte or analytes to be evaluated. The fortified samples will serve as the MS and MSD. In general, an MS will be included in every set of 20 samples tested on each instrument. The MS will then be analyzed. The increase in concentration of the analyte observed in the MS, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery. Control charts will be monitored periodically for each commonly analyzed compound and kept on an instrument-specific, matrix-specific, and analyte-specific basis.

6.3.2 Precision Assessment

Precision of laboratory analysis will be assessed by comparing the analytical results between MS/MSD for organic analysis, and MS/MD results for inorganic analysis. The RPD of primary and second column confirmation analyses will also be monitored for GC/HPLC analyses. The RPD will be calculated for each pair of duplicate analyses as indicated below.

$$RPD = \frac{|S - D|}{\frac{(S + D)}{2}} \times 100$$

Where: S = First sample value (original or MS spike value);

D = Second sample value (duplicate or MSD value).

Spiked samples are prepared by choosing a sample at random from each sample shipment received at the laboratory, dividing the sample into equal aliquots, and then spiking each of the aliquots with a known amount of analyte. The duplicate samples will then be included in the analytical sample set. The splitting of the sample allows the analyst to determine the precision of the preparation and analytical techniques associated with the duplicate sample. The RPD between the spike and duplicate spike will be calculated and plotted.

6.3.3 Completeness Assessment

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed within a specific matrix and/or analysis. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

(number of valid measurements)

(number of measurements planned)

6.3.4 Sample Quantitation Limits/Sensitivity

The sensitivity requirement for each chemical parameter of concern will be based on the Region III Risk-Based Criteria (RBC). The Region III Residential RBCs will be included in tables in the project-specific QAPPs along with the analytical subcontractor's method reporting limits (MRLs) and method detection limits (MDLs). Although the analytical methods selected will provide the highest sensitivity for the parameters in each matrix using standard procedures, some laboratory MRLs and MDLs will be above the Region III RBCs. The analytes where the laboratory detection level exceeds the RBC will be shaded to designate them as such. However, in all instances, detections above the MDLs yet below the MRLs will be reported and qualified, as required.

There will inevitably be instances where Laboratory MRLs and MDLs exceed the Region III RBCs. These nonconformances are due to the fact that the sensitivity goals were developed in accordance with risk-based calculations without regard to the constraints of current analytical technology. Before selection the subcontract analytical laboratory's MDLs and MRLs will be compared to several competitors for the project parameters to ensure that the MRLs and MDLs are generally consistent with industry standards for the required analytical methods.

7.0 DATA REPORTING

Data reporting procedures will be carried out for field and laboratory operations as indicated in the following sections.

7.1 FIELD DATA REPORTING

Field data reporting will be conducted principally through the transmission of report sheets containing tabulated results of all measurements made in the field, and documentation of all field calibration activities.

7.2 LABORATORY DATA REPORTING

Two data report formats will be used based on the sample type being reported. Soil and water investigative sample reports will use a CLP-like, comprehensive data package that can be fully validated. These reports will contain all information and data as required in the applicable CLP Statement of Work and as described below.

Waste characterization sample reports will use a reduced format consisting of the laboratory analytical data sheet listing the analytical results and a case narrative documenting the COC and stating that the chemical analyses were performed in accordance with the specified method and within control criteria. Additionally, any exceptions to these requirements will be documented and a rationale for acceptance of the data will be provided.

Requirements for the comprehensive data packages are as follows.

- Case narrative to include:
  - Date of issuance
  - Laboratory report table of contents
  - Project name and number
  - Laboratory analysis performed
  - Any deviations from intended analytical strategy
  - Laboratory batch number
  - Numbers of samples and respective matrices
  - QC procedures used and also references to the acceptance criteria
  - Condition of samples 'as received'
  - Discussion of whether or not sample holding times were met
- Discussion of technical problems or other observations that may have created analytical difficulties
  - Discussion of any manual integration performed
  - Discussion of laboratory QC checks that failed to meet project criteria
  - Signature of the laboratory department manager
- Sample custody documentation
  - Original signed COC records
  - Cooler receipt forms
- 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 samples to project sample identification numbers
- Data qualifiers applied will be adequately defined
- Sample preparation and analyses methods for samples
- Sample results
- MS/MSD recoveries, MD results, LCSs, MB results, and surrogate results
- Dilution factors, collection dates, extraction dates, and analysis dates
- Laboratory sample spiking levels.

- Calibration data and raw data package
  - Results of (dated) initial and continuing calibration checks, and GC/MS tuning results
  - Calibration check compounds and internal standard results
  - Labeled (and dated) chromatograms/spectra of sample results and laboratory QC checks
  - Raw data for sample results and laboratory QC samples
  - Original and manually integrated chromatograms

7.3 ELECTRONIC DATA REPORTING

An electronic data deliverable (EDD) is also required to accompany each hard copy data report. The Jacob's STAR EDD format will be the only acceptable EDD format The STAR EDD format will be provided in the analytical statement of work. Any questions regarding the STAR EDD format may be directed to the Jacobs Project Chemist.

Each EDD received from the analytical laboratories will be scanned for viruses and loaded into a restricted assess directory in the project file. The data will then be loaded into a database file for format, content, and context evaluation. The laboratories will be notified of the status of each EDD. Any problems or discrepancies will be documented in writing to the laboratories. Simple, minor corrections will generally be made by the Jacobs Data Manager, but require the approval of the laboratory. The Data Manager will decide if the corrections can be accomplished by himself, or if the EDD requires resubmittal. Extensive, complex or ambiguous errors will require laboratory resubmission of the entire EDD.

7.4 LABORATORY TURNAROUND TIME

The hard copy data deliverable and EDD both must be submitted by the due date to satisfy the analytical turnaround time requirement. The analytical data will be due on a turnaround time of 28 calendar days or less. The project-specific QAPPs will detail the analytical turnaround time requirements for each project. The analytical turnaround time begins as day zero on the date of sample receipt at the laboratory. Problems or difficulties with analyses that might cause failure in meeting the analytical turnaround time will be communicated immediately upon discovery to the Project Chemist or Jacobs Project Manager.

7.5 DATA RETENTION, SAMPLE ARCHIVAL AND DISPOSAL

The laboratory will maintain a complete copy of each data submittal for a period of five years after the end of the period of performance date of the analytical subcontract. The data will be maintained in a secure location allowing the files to be readily retrieved at no additional charge to the project. The residual project samples will be archived for a period of 180 days after the analytical subcontract period of performance expires. Sample disposal will be in accordance with all applicable local, state, and federal regulations. Project sample final disposition records will be maintained by the laboratory and provided to Jacobs for inclusion in their final project file.

8.0 DATA MANAGEMENT

8.1 LABORATORY DATA REVIEW PROCEDURES

The laboratory's data review process will be detailed within their SOPs and is summarized in this section. The analyst who generates the analytical data has the prime responsibility for the correctness and completeness of that data. Each step of the review process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that data of quality are generated consistently.

All data generated and reduced will follow well-documented, in-house protocols, including three levels of technical review:

- Level 1 technical data review, performed by the analyst
- Level 2 technical review, performed by a supervisor or data review specialist
- Level 3 administrative cursory data review, performed by the department manager or QA Manager, or designee.

Laboratory review of analytical data will be consistent with SW-846 protocol and applicable laboratory SOPs. One hundred percent of laboratory-generated data will be subjected to internal data review. If matrix interferences are identified during analysis, method modifications such as additional cleanup steps, sample volume changes, and analytical procedure revisions will be attempted and documented. If method modifications do not remedy the problem, alternative procedures will be proposed. The laboratory will assign qualifiers to the data similar to those described within the USEPA CLP National Functional Guidelines to indicate impacts to data use. At a minimum, the laboratory will evaluate the following information, as applicable:

- Calibration (initial and continuing) and tuning (GC/MS) check results
- Analyte identification and quantification are correct
- Correct use of manual integration and the rationale for use
- QC samples and MBs are within control limits
- Data summaries and reports for transcription and typographical errors
- Holding times, sample preservation, and sample storage criteria have been met
- Sample COC documentation for completeness, accuracy, and to ensure sample integrity has been maintained
- Sample preparation information for completeness and accuracy
- Documentation (including the case narrative) is complete and correct.

8.2 DATA VERIFICATION/VALIDATION

Data verification/validation will be performed for both field and laboratory operations as described in the following sections.

8.2.1 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 maintained by the field crewmembers. This task will be the responsibility of the Site Manager or designee, who will otherwise not participate in making any of the field measurements, or in adding notes, data, or other information to the logbook.

8.2.2 Procedures to Validate Laboratory Data

Review of the analytical data will be conducted incrementally on each LDP. Analytical results will be thoroughly reviewed before release to the client. There are three steps for review to achieve acceptable data for the purposes of this project. These steps are defined below.

Step 1 – Laboratory Data Review

The analytical laboratories will review their data before releasing data packages/reports to the Contractor. This step is applicable to all data generated in support of this project. The review process will be as described in Section 8.1 of this QAPP. Analytical reports will contain the analytical results with laboratory QC data. The reports will contain the items described in Section 7.2 of this QAPP.

Step 2 – Data Verification

Jacobs will perform the data verification of 100 percent of the primary sample results. The Jacobs Project Chemist, will be responsible for completing the data verification and assessment. This step is applicable to all primary sample data generated in support of this project.

Data verification is the process of evaluating the completeness, consistency, and compliance of a data package against the QAPP DQOs. This process requires a definitive data package. This verification process will include the following: initial and continuing calibrations and instrument tuning, results of the LCS, the MS/MSD, results of surrogate recoveries, results of any associated method or instrument blanks, and results of duplicates. Jacobs will perform verification of 100 percent of the primary sample results with respect to these QC indicators. The procedure the Contractor will use to complete this process is described in the following section of this QAPP. Data evaluation will be conducted in accordance with the guidance in EM 200-1-3 Appendix I *Shell for Analytical Chemistry Requirements* (February 2001), EPA's *Contract Laboratory Program National Functional Guidelines for inorganic Data Review* (February 1994) and *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (October 1999).

Jacobs will assign and/or change qualifiers that were assigned by the laboratory to match the findings of the data evaluation, without recalculating the positive hits in the data. Complete data tables, summarizing all of the verified analytical results, will be provided in the Chemical Data Quality Report (CDQR) to be submitted to USACE.

Step 3 – QA Sample Validation/CQAR

Jacobs will contract with a qualified independent data validation firm to evaluate and compare the QA sample results to the primary sample results and complete the Chemical Quality Assurance Report (CQAR). Data evaluation will be conducted in accordance with the guidance in EM 200-1-3 Appendix I *Shell for Analytical Chemistry Requirements* (February 2001), EPA's *Contract Laboratory Program National Functional Guidelines for inorganic Data Review* (February 1994) and *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (October 1999).

Data validation will be performed on 100% of the QA sample data and the QA sample results will be compared to the corresponding primary sample results. Comprehensive data packages will be provided for all of these sample analyses. The QA laboratory will report the sample results directly to the independent validation contractor, and Jacobs will provide a table linking the primary and QA samples and the associated primary sample data to the independent validation contractor.

The independent validation firm will validate the QA sample data and compare the results to the associated primary sample data and generate a CQAR report per the guidance of USACE-HTRX-CX *Chemical Quality Assurance for HTRX Projects*, EM-200-1-6, October 1997. Data validation consists of validating the data using the guidance in EM 200-1-3 Appendix I *Shell for Analytical Chemistry Requirements* (February 2001), EPA's *Contract Laboratory Program National Functional Guidelines for inorganic Data Review* (February 1994) and *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (October 1999). Validation includes recalculating the positive hits above the MRL. The validator will qualify the data as "U" for levels below the MRL, "J" for estimated values, and "R" for rejected values.

An independent third party validation of the primary sample data was deemed unnecessary for this program by the USACE at the time this QAPP was generated.

8.2.3 Procedures to Verify Laboratory Data

Data verification (Step 2 of the data assessment process discussed above) will be performed independent of the laboratory generating the data and will be documented in the final report prepared upon receipt of the final LDP of the project. The process will identify any data omissions and out-of-control data points for QC included in the evaluation and interact with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analysis may be made by the PM based on the extent of the deficiencies and their importance in the overall context of the project.

Data evaluations will also be based on the QA/QC requirements of the referenced analytical procedures, QC objectives presented in this QAPP, and professional judgment of the evaluator. At a minimum, specific data verification will include evaluation of:

- Sample receipt records
- Technical holding times
- Constituent MRLs
- Instrument tuning and calibrations
- Field and laboratory duplicate RPD results
- MS/MSD analyses (for organics only)
- MS/Post digestion spike analyses (for inorganics only)

- LCS
- Blank analyses
- SUR analyses (for organics only)
- Laboratory case narratives.

The data quality review will include evaluation of 100 percent of the primary sample data. These data will be evaluated against established criteria defined in the project DQOs, and the criteria established in EM 200-1-3 Appendix I *Shell for Analytical Chemistry Requirements* (February 2001), EPA's *Contract Laboratory Program National Functional Guidelines for inorganic Data Review* (February 1994) and *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (October 1999), and the approved analytical method.

8.2.4 Record Storage

Upon conclusion of the field effort, all field documentation (i.e. maps, well logs, logbooks, and photographs) will be clearly labeled and placed in the project file maintained by the Contractor.

All project-related information generated or received by the Contractor will be maintained by the Contractor. Designated personnel will ensure that incoming records are legible and in suitable condition for storage. A records index will be initiated at the beginning of the project. Each document that is placed into the project file will be logged on the index. The logging of the records will be the responsibility of the document custodian appointed by the project manager. Records storage will be performed during and immediately following the project. The Contractor will arrange for permanent storage of Contractor generated or received records directly related to the project upon conclusion of all activities.

All documents will be stored in areas or storage facilities that provide a suitable environment to minimize deterioration or damage, and that prevent loss. The facilities will, where possible, have controlled access and will provide protection from excess moisture and temperature extremes.

At the conclusion of the project, the project manager or his designated document custodian will be responsible for inventorying the project file. The records contained in the project file will be compared against the records listed on the index, discrepancies must be resolved prior to transferring the file to the permanent storage facility. All project records will be provided to the client in hard copy upon completion of the project. The Contractor will maintain copies of these records for three years following the close of the project.

9.0 REFERENCES

1. EPA, January 2000. Final *Data Quality Objectives Process for Hazardous Waste Site Investigations*, QA/G-4HW, 2000, Office of Environmental Information, Washington, DC.

2. EPA, March 2001. *EPA Requirements for Quality Assurance Project Plans (QA/R-5).* EPA/240/B-01/003.

3. EPA, December 1996. *Test Methods for Evaluating Solid Waste, Final Update III*, SW-846.

4. EPA, October 1999. *Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA 540/R-99/008, OSWER 9240.1-05A-P.

5. EPA, February 1994. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA 540/R-94/013, OSWER 9240.1-05-01.

6. US Army Corps of Engineers, September 1994. *Requirements for the Preparation of Sampling and Analysis Plans.* EM-200-1-3.

7. US Army Corps of Engineers, 1997. *Chemical Quality Assurance for HTRX Projects.* EM-200-1-6.

TABLES

Table 3-1
Precision and Accuracy Goals

Analysis	QC Check	Acceptance Limits
SW-846 8260B VOCs	GC/MS Tune	BFB tune must meet the ion abundance criteria in the method
	ICAL	SPCC compounds must meet method requirements, and CCCs must have RSD≤ 30%. Other target analytes shall have RSD ≤ 15% (r 0.995 or r2 0.990) or mean RSD for all target analytes ≤ 15% with no individual analytes > 30%.
	ICV (must be second source)	80-120%
	CCV	SPCC compounds must meet method requirements, and CCCs must have D< 20%, mean D ≤20% with a max D for each analyte ≤30%
	Internal Standards	-50% to +100% area of midpoint
	Method Blank	<1/2 MRL
	LCS Recovery	80-120% waters, 75-125% soils
	MS/MSD Recovery	70-130%
	MS/MSD RPD	30% (SPMF 40%)
	Surrogate Recovery	70-130%
SW-846 8081A Pesticides	Breakdown Check (DDT/Endrin)	may not exceed 15% for DDT or Endrin
	ICAL	RSD ≤ 20% or r> 0.99
	ICV (must be second source)	85% to 115%
	CCV	mean D ≤ 15% with no target %D > 30%
	Method Blank	<1/2 MRL
	LCS Recovery	50-130%
	MS/MSD Recovery	40-140%
	MS/MSD RPD	50%
	Surrogate Recovery	40-140%
	Second Column Confirmation	RPD ≤ 40%
SW-846 8082 PCBs	ICAL (1016/1260 five points/three peaks per aroclor)	RSD ≤ 20% or r>.99
	ICV (must be second source)	85% to 115%
	CCV	mean D ≤ 15% with no target %D > 30%
	Method Blank	<1/2 MRL
	LCS Recovery	50-130%
	MS/MSD Recovery	40-140%
	MS/MSD RPD	50%
	Surrogate Recovery	40-140%
	Second Column Confirmation	RPD ≤ 40%

Table 3-1 (continued)

Analysis	QC Check	Acceptance Limits
SW-846 8310 PAHs	ICAL	RSD ≤ 20% or r>.99
	ICV (must be second source)	85% to 115%
	CCV	mean D ≤ 15% with no target %D > 30%
	Method Blank	<1/2 MRL
	LCS Recovery	60-120%
	MS/MSD Recovery	50-140%
	MS/MSD RPD	50%
	Surrogate Recovery	50% to 150%
	Second Column Confirmation	RPD ≤ 40%
SW-846 8330 Explosives	ICAL	RSD ≤ 20% or r>.99
	ICV (must be second source)	85% to 115%
	CCV	mean D ≤ 15% with no target %D > 30%
	Method Blank	<1/2 MRL
	LCS Recovery	60-120%
	MS/MSD Recovery	50-140%
	MS/MSD RPD	50%
	Surrogate Recovery	50% to 150%
	Second Column Confirmation	RPD ≤ 40%
SW-846 8151 Herbicides	ICAL	RSD ≤ 20% or r>.99
	ICV (must be second source)	85% to 115%
	CCV	mean D ≤ 15% with no target %D > 30%
	Method Blank	<1/2 MRL
	LCS Recovery	50-130%
	MS/MSD Recovery	40-140%
	MS/MSD RPD	50%
	Surrogate Recovery	40-140%
	Second Column Confirmation	RPD ≤ 40%
SW-846 6010B ICP Metals	ICAL	r ≥ 0.995
	ICV (must be second source)	90% to 110%
	CCV	90% to 110%
	Blanks (method, calibration,etc.)	<MDL
	ICS	80% to 120%
	LCS Recovery	80%-120%
	Matrix Spike	75% to 125%
	Matrix Duplicate	≤ 25% RPD
	Post Digestion Spike	75% to 125%
	Serial Dilution	4 fold dilution within 10% D of original result

Table 3-1 (continued)

Analysis	QC Check	Acceptance Limits
SW-846 7000 Series GFAA Metals	ICAL	r ≥ 0.995
	ICV (must be second source)	80% to 120%
	CCV	80% to 120%
	Blanks (method, calibration,etc .)	<MDL
	LCS Recovery	80% to 120%
	Matrix Spike	75% to 125%
	Matrix Duplicate	≤ 25% RPD
	Post Digestion Spike	75% to 125%
	Serial Dilution	4 fold dilution within 10% D of original result
SW-846 7470A/7471A Mercury	ICAL	r ≥ 0.995
	ICV (must be second source)	80% to 120%
	CCV	80% to 120%
	Blanks (method, calibration,etc.)	<MDL
	LCS Recovery	80% to 120%
	Matrix Spike	80% to 120%
	Matrix Duplicate	≤ 25% RPD
Various Wet Chemistry Methods	Calibration	per method
	Calibration Verification	per method
	LCS	50% to 150%
	Method Blank	<1/2 MRL
	MS/MSD Recovery	50% to 150%

BFB = 4-bromofluorobenzene
CCC = Calibration Check Compound
CCV = Continuing Calibration Verification
D = percent difference (Drift)
GC/MS = Gas Chromatography/Mass Spectrometer
GFAA = graphite furnace atomic absorption
ICAL = Initial Calibration
ICP = Inductively Coupled Plasma
ICV = Initial Calibration Verification
LCS = Laboratory Control Sample
MRL = Method Reporting Limit
MS/MSD = Matrix Spike/Matrix Spike Duplicate
PCB = polychlorinated biphenyl
QC = Quality Control
RPD = Relative Percent Difference
RSD = Relative Standard Deviation
SIM = Selected Ion Monitoring
SPCC = System Performance Check Compound
SPMF = Sporadic Marginal Failure
SVOC = semivolatile organic compounds
VOC = volatile organic compounds

Table 5-1
Laboratory Preventive Maintenance Activities

Instrument	Maintenance Parameters	Frequency	Spare Parts
Gas Chromatograph (GC)	Liner insert, column, glass wool plug, detector, thermal traps	As-needed basis; determined by analyst to meet method QA/QC requirements	Columns, traps, septa, liners, syringes, ferrules, fittings, tubing, detector-specific items
	Replace septa	As needed	
	Gas drying and purifying cartridges	When indicated to be necessary	
	Effluent absorbent traps	Monthly	
	Oven performance	Daily, as part of retention time check of standards	
Gas Chromatograph/ Mass Spectrometer (GC/MS)	Same as GC plus the following items:	As needed	Same as GC plus the following items: ion source and analyzer parts, electron multiplier, filaments, filters, pump oil, gaskets, and o-rings
	Incoming line voltage	As needed	
	Vacuum pump oil	Annually	
	Turbo pump check	Annually	
	Ion source and analyzer cleaning	As needed	
	Power supply voltage	As needed	
High Performance Liquid Chromatograph (HPLC)	Analytical column, detector, pump	As-needed basis; determined by analyst in order to meet method QA/QC requirements	Frits, connecting lines, gaskets
	Replace guard column	As needed	
	Replace frits on guard column	As needed	
	Clean flow cell on post-column detector	As needed	

Table 5-1 (continued)

Instrument	Maintenance Parameters	Frequency	Spare Parts
Atomic Absorption (AA)	Gas flows, cell alignment, slit width, photomultiplier voltage, lamp intensity	Daily; change as needed	Graphite tubes, nebulizers, quartz windows, contact rings, and lamps
	Graphite tubes and contact rings	Daily, or as needed	
	Visual inspection of burner head assembly and quartz cells for signs of contamination	Daily, or as needed	
	Tubing		
	Optical lenses	Quarterly, or when deterioration is noted	
	Clean furnace windows	As needed	
		Daily, or as needed	
Inductively Coupled Plasma Spectrophotometer (ICP)	Aspirator assembly inspection	Daily	Torches, nebulizers, pump tubing, torch collars, and vacuum oil
	Pumps and tubing inspection	Weekly	
	Nebulizer and sample probe cleaning	Monthly, or as needed	
	Filters	Quarterly	

APPENDIX A
Response To Comments

CELRN-EC-R-D (200-1c) 21 April 2004

MEMORANDUM FOR CELRN-EC-R-M (Ingram)

SUBJECT: Response to comments from Review of Draft Site-Wide Quality Assurance Project Plan, Sandusky, Ohio, Dated February 2004, Prepared by Jacobs Engineering Group, Inc., Contract Number DACW62-03-D-0004-0002

Reviewer: CELRN – Becky Terry

1. **Completion of Independent Technical Review. Virgil Jansen is listed as both a independent technical reviewer and also the project manager. Per the COE guidance he cannot be both. Also please identify the discipline of each technical reviewer.**

Response: The final document will list Virgil Jansen as the project manager only, and the disciplines of each reviewer will be identified.

2. **Page 1. Section1.0. First sentence. The Field Sampling Plan comprises the QAPP and the SAP. Correct.**

Response: The statement will be reworded to state that the SAP is made up of the combination of the QAPP and FSP.

3. **Page 3. Section 2.1. First paragraph. Last sentence. The analytical data shall be validated at 100%. See SOW Section 3.5.2.2. Second paragraph.**

Response: This statement is referring to third party validation, and will be removed since third party validation is not required per the SOW.

4. **Page 11. Section 4.2. Check sentence for grammatical errors that begins with "Sample preparation".**

Response: Agree. The fragment *"may be completed within the sample holding time"* will be deleted.

Subject: Response to review comments for the Site-Wide Sampling and Analysis Plan, Remedial Investigation, Part 1, at Reservoir No. 2 Burning Ground (2BG), Former Plum Brook Ordnance Works, Sandusky, Ohio, March 2004, prepared by Jacobs Engineering.

Reviewer Name: **Groenjes, Cheryl (Chemistry) – HTRW Center of Expertise**

Comment # 1: FSP p.5-8. There is no benefit in analyzing a sample for dissolved explosives. I have gleaned some facts from a technical resource on explosives for consideration: Suggest deletion of this protocol.

8.2 Considerations When Sampling Explosives

Because of the physical properties of explosives, they do not readily volatilize from solution or dissociate in solution (i.e., form charged species). They are also relatively hydrophilic and thus do not tend to sorb or partition into organic matter. Thus, we would expect that these analytes would not have a great affinity for other solid phase materials, particulates, or colloids. Therefore, high turbidity in samples, mobilization of colloids during sampling, and colloidal transport in groundwater are not significant issues when sampling for explosives.

8.7 Sample Collection, Handling, and Storage

Groundwater containing explosives should be collected in amber glass bottles to prevent photodegradation. For low concentrations (ppb levels), a 1-liter bottle is required. The sample does not need to be filtered but should be acidified to a pH of 2 using sodium bisulfate (Jenkins et al., 1995) and kept cold (4 °C). Because of the relatively low solubility of explosives in water, there are no special safety concerns associated with shipping groundwater samples containing explosives.

Response: Agreed. Groundwater samples will only be analyzed for total explosives, and they will be collected in one liter amber glass containers preserved with sodium bisulfite (ph<2).

Comment # 2: FSP p. 5-10, 5.5.1.

a. The use of the term QA to describe field QC samples such as rinsates is not recommended. The "QA" term is used by the Corps to represent a replicate sample sent to a referee laboratory, which is correctly presented later in the SAP (QAPP 2.2).

Response: Agreed. QA will be changed to field QC samples.

b. Encore samplers are not composed from stainless steel, nor do they use sleeves, end caps or Teflon tape. The procedures are not applicable to the device. Suggest revising to protocols obtained from En Novative Technologies, Inc. at http://www.ennovativetech.com/encore/encore.htm . The T-handles and extrusion devices may be made of stainless steel, but they do not come in contact with the sampled media.

Response: Agreed. This procedure will be revised.

c. Protocols are not included that address the remaining samples to be acquired. Refer to EM 200-1-3, appendix E-5 for information on appropriate E-2 for homogenization of soil media for acquisition of samples for the remaining semi-volatile and non-volatile parameters.

Response: The second sentence in this section refers to the collection of non-VOC samples using a stainless steel bowl and spoon. Homogenization of the soil will be added to the protocol.

Comment # 3: FSP p. 5-10, 5.5.2. Along the same lines as comment 2a and 2b, protocols must be included within this section to address the appropriate sample handling procedures for subsurface soils. Refer to EM 200-1-3, appendices E-5 for VOCs, and E-2 for homogenization techniques and acquisition of remaining parameters.

Response: This section will be revised and will include sampling protocols for VOC and non-VOC samples

Comment # 4: FSP p. 5-11, 5.5.3. Refer to EM 200-1-3, E-2 for appropriate procedures for homogenization of soils prior to acquisition of non-VOC parameters.

Response: This section will include sampling protocols for non-VOC samples.

Comment # 5: FSP p. 5-12, 5.6. Appropriate sediment sampling devices are not identified within this document, nor are referenced SOPs provided. Suggest including basic information on the type (grab, core, etc.) to be used for sampling of sediments and/or including the noted SOPS within this comprehensive SAP.

Response: Sampling devices are discussed in the 4th paragraph. The Jacobs work instruction is included in the 6th paragraph. The use of a stainless steel spoon to collect non-VOC samples will be included in this section.

Comment # 6: FSP p. 5-13, 5.7.

a. 3rd paragraph. I'm unfamiliar with the use of a rod to extend the peristaltic intake line to the appropriate depth. Suggest replacing with the use of Teflon tubing for ease of use (can be dedicated) and cut to appropriate lengths based on water measurements of the SW body. If the rod is retained, define its length, composition, and how it will be deconned. How do you vary the length?

Response: Additional descriptions will be provided for this sampling protocol. The use of a rigid rod allows the sampling technician to properly place the intake line without entering the water. The tubing will be lashed to the rod and will extend approximately 3 inches beyond the end of the rod. The length of the rod needs to be sufficient to reach the desired sampling point. The rod never comes in direct contact with the water and therefore does not require decontamination. This approach as stated in the text is used in circumstances where entry into the water by the sampling technician would result in turbid samples. Tygon tubing will be used and disposed after each sampling location.

b. 4th paragraph. The use of the lid when filling VOC vials should be suspended. Suggest the low-velocity stream of SW flow down the (inside) sidewalls of the vial as it fills. Suggest a caution to prevent over-filling be added to the discussion on obtaining a convex meniscus – for that is when you wash out the preservative.

Response: The text will be revised to include a partial fiilling of the vial by direct fill methods when feasible. The final amount however will be collected with the lid to form a proper meniscus and to avoid flushing the preservative from the vial. The use of the lid for creating a meniscus is standard practice with groundwater sampling and should be allowed for surface water sampling.

c. Refilling of the vials do not result in the loss of preservative – the discarding of the previous sample causes the loss. Refilling of the vial requires preservation be done from bulk preservatives brought to the field. Augment this section to address these omissions.

Response: The intent of this section was to provide instruction to avoid discarding the sample and refilling of a vial. Additional clarification will be provided to indicate that new preserved vials will be used.

Comment # 7: FSP p. 6-6, 6.4. No analytical is described in this paragraph. Edit heading to what is discussed.

Response: This section discusses field documentation of analytical samples. It describes the types of information about the analytical samples that will be recorded while in the field.

Comment # 8: FSP p. 7-1, 7.0. Filtration techniques should be performed in the field as soon as possible to maintain sample integrity and comparability in data. Edit text here for compliance with that stated in section 5.4.4 on GW sampling.

Response: The option to send unfiltered samples to the laboratory for lab filtration will be removed.

Comment # 9: FSP p. 8-1, 8.2. The use of RBCs as a comparative value for IDW is unfounded and inappropriate. Suggest as an alternative, that the results for the associated samples be used along with the 20 times rule to evaluate a very conservative (assumes 100% is leachable) estimate for the associated TCLP value. I can provide a white paper on this approach if desired to help convey this evaluation. These estimated values for the TCLP can then be compared directly to the RCRA standards outlined in 40 CFR 261.20 through 261.24.

Response: IDW segregation based on analytical results is simply a method to consolidate soil into logical populations prior to routine waste characterization (TCLP, ignitability, corrosivity, and reactivity). This will minimize the number of characterization samples needed and will prevent non-hazardous material from being mixed with potentially hazardous material. Disposal options are not going to be based on RBC comparisons.

Comment # 10: FSP p. 9-2, 9.2. Typo LHAAP → PBOW.

Response: The typo has been noted and will be corrected.

Comment # 11: QAPP p. 6, 3.2.1. Suggest method modification needs be evaluated in light of project-specific COC or COPCs - and discussed here in order to optimize data generated as useful for its intended purpose.

Response: A statement will be added to the section suggesting that method modifications be explored as a possible way to achieve some of the screening criteria for COCs that are outside the realm of the normal analytical method capabilities.

Comment # 12: QAPP p. 12, 5. Refer to EM 200-1-3, section I.3.3.7.2 and I.3.3.7.3 for details on how results must be qualified (J-flagged) to relate the estimation of values reported below the MQL – which is 3-times the MDL. MRL can report down to MDL or 2xMDL – but the values must be J-flagged.

Response: Section 5.1 will be amended to include the qualification of estimated data. Section will also be corrected for the three times the MDL rule. For the purposes of this QAPP the MQL and MRL are intended to be the same value. The MRL definition will be corrected to reflect the requirement for being at least 3x greater than the MDL.

Comment # 13: QAPP p. 16, 5.4.3.1. The MB criteria established in the Shell (I.11.4.1) for the majority of compounds (all except common contaminants to ½ MRL.

Response: Agreed. The language will be amended to require the analytical subcontractors to report the method blanks to ½ the MRL rather than to the MDL. The method blanks will be evaluated per the shell requirements (to ½ the MRL, except common laboratory contaminants).

Comment # 14: General and QAPP p. 40, table 3-1.

a. The acceptance criteria noted here are oversimplified for the sake of brevity. However, the following does not represent what is presented within the EPA SW-846 methods or the Shell for Analytical Chemistry Requirements (Appendix I) of EM 200-1-3. Method 8260B ICAL is not compliant with 8260B 7.3.6.2 and Shell I.9.2.2. CCC only evaluation is not correct – must be all target analytes for ICAL. The use of the mean %RSD or mean %D requires additional documentation and constraints as noted in the last paragraphs of I.9.2.2. Suggest the adoption of footnotes or other means to ensure compliance.

b. Method 8330 must be modified slightly to detect and quantitate for PETN. The same extract can be used, however, the UV wavelength for PETN detection is at 210nm, with the remainder of the nitroaromatics being monitored at 254nm established within the method. This change is not a typical method option, nor is it addressed within the method. Therefore these details must be addressed within the appropriate QAPP documents.

Response: a) The table will be expanded to fully list the requirements of the methods and the Shell document.

b) PETN is not currently a target analyte of concern at this site. If the scope changes to include the need for analysis of PETN, the modifications will be added to the site specific QAPP.

Reviewer Name: Crain, Mike (Geology) – HTRW Center of Expertise

Comment # 1: Field Sampling Plan, 5.5.2, 2nd par, pgs 5-10 and 5-11 – The criteria for selection of soil samples for laboratory analysis need to be established in the site specific work plans based on the data needs and data quality objectives for each sampling effort. During the planning process, the project team needs to decide which criteria are the most appropriate for the contaminants of concern and the intended use of the data and then provide the field geologist with some type of decision matrix to follow that communicates the goals and objectives in a way that they can use in the field.

Response: Agreed. The Site-Specific SAP addresses the investigation DQOs and provides decision criteria for field implementation.

Comment # 2: Field Sampling Plan, 5,7, pg 5-13, 2nd paragraph – There appears to be an omission in the second sentence. Should the sentence say "Sampling will be conducted in a manner that does *not* disturb sediment..." Please correct or clarify as appropriate.

Response: Yes. The word "not" was omitted. The sentence will be corrected.

Comment # 3: Field Sampling Plan, 5.9 pg 5-14 – The elevation of the control monuments need to be measured at least to the nearest 0.01 foot to allow the elevations of the monitoring well casings to be measured to the nearest 0.01 foot. The control monuments actually have to be established with a greater degree of precision than the monitoring wells. The precision specified for the monitoring wells is appropriate but the precision for the control monuments needs to be lowered, preferably to 0.005 foot.

Response: This section will be revised. It has been determined that adequate control monuments exist at the facility. Additional monuments will not be required.

Reviewer Name: Charles G. Coyle (Env. Engineer) – HTRW Center of Expertise

Comment # 1: p. 5-7, 5.4.4 The text states that low-flow purging will be performed at a rate that allows for stabilization of the water column at a level no lower than 4" below original pre-pumping levels. Concur that this is a reasonable criteria for the low-flow sampling procedure. Recommend revising to explain how water level will be monitored during sampling.

Response: The text will include a discussion on constant water level monitoring during purging. Water level measurements will be recorded along with water quality parameters and purge volumes.

Comment # 2: p. 5-8, 5.4.4 The text states that during purging and sampling field measurements of pH, Eh, temp, turbidity and conductivity will be performed every 5 minutes. Dissolved oxygen is generally a more reliable indicator of redox conditions than Eh (except for in anaerobic zones). Recommend revising to require testing for dissolved oxygen as one of the field measurements.

Response: Agree. Monitoring for DO is planned but was omitted from the text. The text will be revised to include DO

Comment # 3: p. 5-8, 5.4.4 This section should be revised to require testing for Mn II and Fe II immediately after sampling is performed, in the field, using a HACH or equivalent field test kit. Note that after 1 or 2 rounds of sampling, if it is determined that Mn II levels are insignificant, further Mn II testing could be eliminated.

Response: The comment is acknowledged. Specific sampling requirements are addressed in the Site-Specific SAP.

Comment # 4: p. 5-10, 5.5 Note that data on TOC levels (in groundwater, soil from the aquifer matrix, and also from sediments), will be important from a natural attenuation perspective (especially with regard to adsorption and irreversible binding of nitroaromatics, see Haderlein,

S.B., Schwarzenbach, R.P; Environmental Processes Influencing the Rate of Abiotic Reduction of Nitroaromatic Compounds in the Subsurface. In: «Biodegradation of Nitroaromatic Compounds», J.C. Spain (Ed.). Plenum Press, New York 1995, pp.199-225. [1993). During future investigation work in areas where nitroaromatics are present, recommend requiring that groundwater, aquifer soil and sediment samples be tested for TOC.

Response: The comment is acknowledged. Specific sampling requirements are addressed in the Site-Specific SAP.

RE: NASA Plum Brook Station
Erie County

April 28, 2004

United States Army Corps of Engineers
Nashville District
Attn: CELRN-EP-R-M (Ms. Linda Ingram)
Estes Kefauver Federal Building
801 Broadway
Nashville, Tennessee 37202-1070

Dear Ms. Ingram:

Please find below the response to comments for the commentary of the Ohio Environmental Protection Agency (Ohio EPA) with respect to the Site-Wide Sampling and Analysis Plan (SAP), Former Plum Brook Ordnance Works as well as the corresponding Site-Specific Quality Assurance Project Plan (QAPP).

General Comment
The Site-Wide SAP details general investigatory methodologies/protocols. Section 1.0 states that for those investigations at specific areas of concern at the former Plum Brook Ordinance Works detailed site-specific attachments to the SAP will be submitted. Ohio EPA concurs with this approach to have general investigatory methodologies/protocols in one document with accompanying and more detailed site-specific methodologies/protocols included as attachments as warranted.

Response: Jacobs agrees and will maintain this approach.

Section 3.2
The Site-Wide SAP states that ground water analytical data will be screened against maximum contaminant levels (MCLs) and United States Environmental Protection Agency (USEPA) Region III risk-based concentrations (RBCs) for Tap Water. Ohio EPA is not amenable to the above approach of standards comparison. In general, MCLs are "Applicable or Relevant and Appropriate Requirements" (ARARs) and, as such, are not considered appropriate as risk based values for the screening of constituents of concerns in ground water. Ohio EPA recommends the use of USEPA Region IX Preliminary Remediation Goals (PRGs) as the primary source of risk based screening values. Implementation of this strategy will ensure consistency with previous investigations in which PRGs were utilized. Please note that USEPA Region IX PRGs for non-carcinogens should be adjusted by a factor of 0.10 to allow for multiple chemical exposure screening considerations.

Response: Agree. The screening criteria will be amended to the Region IX PRGs.

Section 3.2
The Site-Wide SAP states that the classification and compliance determination of ground water will follow those criteria noted in Ohio Administrative Code Rule 3745-300-10 (i.e., the Voluntary Action Program or "VAP"). Utilization of the VAP investigatory approach and associated rule citations in support of the installation restoration program (IRP) investigation at the former Plum Brook Ordinance Works is inappropriate.

Response: Per discussions with John Weaver (OEPA) the objective to determine groundwater classification for the shallow overburden at Plum Brook has already been resolved. The OEPA has determined that the overburden groundwater at Plum Brook does not meet the standards for a drinking water source. The objective and discussion on groundwater classification for the shallow overburden will therefore be removed from the Site-Wide SAP.

Section 5.4
The Site-Wide SAP does not explicitly state what material will be used to construct the shallow (overburden) and bedrock monitoring wells. The material, along with a more detailed discussion of how the well material will be installed in the borehole, should be included in this section. Additional information pertaining to the equipment and techniques for coring the bedrock monitoring wells should be provided.

Response: This information will be provided and specific details will be provided in the Site-Specific SAP Section 5.0.

The purging information diagram on the Well Development Record (Figure 5-4) appears to be mis-labeled. The diagram does not contain an Item B but the 'measured well depth' is represented by Item E. This labeling disparity is carried through the formulas/calculations making it difficult to interpret and to determine the total purge volume. Ohio EPA recommends forgoing the use of the diagram in favor of providing the calculations and required fields of information.

Response: The typo will be corrected. Parameter "E" on the schematic diagram will be replaced with "B"

Section 5.4.3
The section should be revised to note the equipment that will be used for performing water level monitoring.

Response: The use of a Solinst SOL1 Water Level Meter or equivalent will be included in the text.

The Site-Wide SAP should identify the contracted laboratory and provide a table of practical quantification limits (PQLs) and method detection limits (MDLs) for all matrices. If the aforementioned information has yet to be determined, then it should be included in a site-

specific attachment. In addition, the Quality Assurance Project Plan (QAPP) for the contracted laboratory should be provided.

Response: The analytical subcontractors and their MRLs and MDLs will be provided in each of the Site-Specific SAPs for the specific matrices and methods for each specific project. The site-specific QAPP also contains the procedures for each applicable method from the primary and QA analytical subcontractors. Jacobs has received and reviewed the QAPPs for each analytical subcontractor as part of the development of the Site-Specific QAPP. Jacobs maintains the analytical subcontractor QAPPs on file and can provide them to the OEPA under separate cover upon request.

As general reminder, the contracted laboratory must be able to achieve PQLs or MDLs that provide the lowest limit of detection for the corresponding analytical method as specified in USEPA SW-846 Methods and that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Response: The laboratory MDLs are required to be determined per 40 CFR, Part 136, Appendix B or an equivalent statistical approach. The laboratory MRLs are required to be set at the laboratory MQL (or PQL) for this project to achieve as many of the project's risk based criteria as possible. In addition the analytical subcontractors are also reporting detected concentrations of target analytes down to their MDL values qualified as estimated "J".

An example sample container label should be provided in the Site-Wide SAP.

Response: Section 6.3.2 will be amended to include a reference to figure 6-2, the example label that will be included as part of the figures Section of the Site-Wide FSP.

CELRN-EC-R-D (200-1c) 21 April 2004

MEMORANDUM FOR CELRN-EC-R-M (Ingram)

SUBJECT: Response to comments from Review of Draft Site-Wide Quality Assurance Project Plan, Sandusky, Ohio, Dated February 2004, Prepared by Jacobs Engineering Group, Inc., Contract Number DACW62-03-D-0004-0002

Reviewer: CELRN – Becky Terry

1. **Completion of Independent Technical Review. Virgil Jansen is listed as both a independent technical reviewer and also the project manager. Per the COE guidance he cannot be both. Also please identify the discipline of each technical reviewer.**

Response: The final document will list Virgil Jansen as the project manager only, and the disciplines of each reviewer will be identified.

2. **Page 1. Section1.0. First sentence. The Field Sampling Plan comprises the QAPP and the SAP. Correct.**

Response: The statement will be reworded to state that the SAP is made up of the combination of the QAPP and FSP.

3. **Page 3. Section 2.1. First paragraph. Last sentence. The analytical data shall be validated at 100%. See SOW Section 3.5.2.2. Second paragraph.**

Response: This statement is referring to third party validation, and will be removed since third party validation is not required per the SOW.

4. **Page 11. Section 4.2. Check sentence for grammatical errors that begins with "Sample preparation".**

Response: Agree. The fragment *"may be completed within the sample holding time"* will be deleted.