FINAL
PLAN OF OPERATIONS

Stabilization, Excavation and Disposal of Contaminated Soil
Plum Brook Ordnance Works
Sandusky, Ohio

Contract No. DACW69-00-D-0021
Work Order No. 020

Prepared for:

Department of the Army
Huntington District, Corps of Engineers
Huntington, WV

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Definitions and Acronyms

COC	Constituents of Concern
DNT	Dinitrotoluene
EPA	United States Environmental Protection Agency
GSA	General Service Administration
HAZWOPER	Hazardous Waste Operations and Emergency Response
HTF	Hypersonic Tunnel Facility
HTRW	Hazardous, Toxic, and Radioactive Waste
IQCT	Independent Quality Control Team
IDW	Investigation Derived Waste
MSDS	Material Safety Data Sheet
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety & Health Administration
PAH	Polynuclear Aromatic Hydrocarbons
PBOW	Plum Brook Ordnance Works
PBS	Plum Brook Station
PCBs	Polychlorinated Biphenyls
PEL	Permissible Exposure Limit
POC	Point of Contact – technical point of contact for the U.S. Army Corps of Engineers
PPE	Personal Protective Equipment
PRGs	Preliminary Remediation Goals
RPDs	Relative Percent Differences
QA	Quality Assurance

QC	Quality Control
QAP	Quality Assurance Plan
QCP	Quality Control Plan
REIC	Research Environmental and Industrial Consultants
SOW	Scope of Work
SSHO	Site Safety and Health Officer
SSHP	Site-Specific Safety and Health Plan
USACE	United States Army Corps of Engineers
TCLP	Toxicity Characteristic Leaching Procedure
TNT	Trinitrotoluene
TWA	Time Weighted Average

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1.0 PROJECT DESCRIPTION

1.1 Introduction and Site History

The site of the former Plum Brook Ordnance Works (PBOW) is located approximately 4 miles south of Sandusky, Ohio and 59 miles west of Cleveland, Ohio. Although primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is bounded on the north by Bogart Road, on the south by Mason Road, on the west by County Road 43, and on the east by U.S. Highway 250. The surrounding area is mostly agricultural and residential.

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 at PBOW began in December 1941 and continued until 1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during the 4-year operating period. The three explosive manufacturing areas were designated TNT Area A (TNTA), TNT Area B (TNTB), and TNT area C (TNTC). Twelve process lines were used in the manufacture of TNT, four lines at TNTA, three lines at TNTB, and five lines at TNTC. The work to be performed under this project deals primarily with the TNTB area.

The TNTB manufacturing site consisted of widely scattered buildings of wood frame construction with asbestos and sheet metal coverings. It also included a series of buried and/or overhead flumes and pipes used to transport various liquids associated with the manufacturing process. After plant operations ceased, TNT B's manufacturing lines were decontaminated by the War Department in late 1945. During decontamination, all structures, equipment, and manufacturing debris were either removed and salvaged or removed and burned by the War Department in 1945. After the property was certified decontaminated by the US Army, the property was initially transferred to the Ordnance Department and then to the War Assets Administration. In 1949, PBOW was transferred to the General Services Administration (GSA). In 1955, the GSA completed further decontamination of TNTB. This effort supposedly focused on surface contamination detected by visual inspection. It is unknown whether the underground flumes were addressed by this decontamination effort.

The National Aeronautics and Space Administration (NASA) acquired the property on March 15, 1963 and currently utilizes the site. GSA performed further decontamination efforts during the 1963 transfer. The decontamination process included removing contaminated surface soils above the drain tiles, flumes, etc., destruction of all buildings by fire, and the removal of all soil, debris, sumps, and concrete foundations. All materials, including the soil in those areas, were flashed. The area was then rough graded. The decontamination process also included the burning of excavated nitroaromatic filled flumes.

NASA currently operates the Plum Brook Station (PBS) of the John Glenn Research Center at Lewis Field. Most of the aerospace testing facilities built in the 1960's at the site are in standby or inactive status. On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. The Perkins Township Board of Education acquired 46 acres of the excess acreage and uses this area as a bus transportation area. GSA retains ownership of the remaining of the excess acreage and currently has a use agreement with Ohio National Guard for 604 acres of the land. NASA presently controls approximately 6,400 acres and is using the site to conduct space research as a satellite operation of the John Glenn Research Center at Lewis Field.

TNTB consists of an area of approximately 55 acres at the south-central portion of PBOW immediately north of West Sheid Road. Significant evidence of former PBOW facilities exists at TNTB in form of roads, hydrants, and ditches. All the buildings that had been present during the TNT manufacturing were demolished and removed. Two NASA facilities are present at the site and are currently active, the Hypersonic Tunnel Facility (HTF) and Nitrogen Dewar Tanks. The HTF is located in the northwest portion of TNTB and consists of a single building, above and below-ground piping and utilities, and paved parking areas. The Nitrogen Dewar Tanks are located in the center of TNTB with aboveground piping and underground utilities leading to the northwest towards the HTF and to the northeast offsite.

1.2 Overview of Remedy

Remedial Investigation (RI) fieldwork was conducted in 1998 in order to provide a basis for taking an action at this site. As part of the RI, 391 soil samples were collected and field screened for nitroaromatics. Additionally, 40 confirmation soil samples were collected to supplement the on-site screening analysis for standard laboratory analysis using SW-846 Method 8330 with second column confirmation. A human health risk assessment was conducted for TNTB. Thirteen constituents of concern (COC) were identified in surface and subsurface soil. Six of the COCs are nitroaromatics {2-amino-4,6-dinitrotoluene (DNT); 4-amino-2,6-DNT; 2,6-DNT; 2,4-DNT; 2-nitrotoluene; and 2,4,6-trinitrotoluene (TNT)}. The remaining seven COCs are polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAHs). The PCBs detected on-site are Aroclor 1254 and Aroclor 1260. The PAHs detected on-site are benzo (a) anthracene, benzo (a) pyrene, benzo (a) fluoranthene, dibenzo (a,h) anthracene, and indeno (1,2,3-cd) pyrene. Lead, which was not listed as one of the COCs, was also found at various levels, and if encountered at values exceeding regulatory levels, it will need to be disposed of in accordance with applicable state and federal regulations.

The proposed approach for a remedy at the TNTB area is to excavate, remove, and dispose of contaminated soil from 30 areas in which the concentration of the COCs in soil exceeds the preliminary remediation goals (PRGs). Refer to the Table 1 in Section 3.1 for the PRGs for this site. The estimated volume of contaminated soil from all 30 areas of the TNTB is 3,300 cubic yards. Refer to Task 6 in Section 1.2.1 of this plan for a brief description of each area and the contaminant(s) of concern in those areas. Pursuant to the Scope of Work, representative soil samples from each excavated area will be analyzed for toxicity characteristic leaching procedure (TCLP) volatiles, semi-volatiles, and metals. Using existing soil data, the estimated volume of excavated soil that may be classified, as hazardous waste based on 2,4-DNT concentrations is approximately 560 cubic yards. An additional 400 cubic yards of material might be identified as a hazardous waste due to the high levels of lead. Any soil identified as hazardous waste shall be treated (i.e. stabilized) to achieve "special" waste classification prior to land disposal in a non-hazardous waste landfill.

1.2.1 Tasks

The following tasks are required to be performed under this Scope of Work:

Task 1 Preparation and submission of a Site Specific Safety and Health Plan.

Task 2 Preparation and submission of a Quality Control Plan.

Task 3 Preparation and submission of a Plan of Operations, which shall include information on the disposal of Investigation Derived Waste, Erosion Control Plan, Spill Containment Plan, Sampling and Analysis Plan, Environmental Protection Plan and a Materials Handling Plan.

Task 4 Notification/ scheduling of field activities and coordination of utility marking with NASA officials prior to site mobilization.

Task 5 Site surveying is necessary for identifying limits of excavation.

Task 6 Excavation of Contaminated Material (removal of approximately 3,300 cubic yards of contaminated material from 30 areas in the vicinity of the former TNT Area B site).

<u>Building 412 Sweating and Graining House.</u> Total remediation volume is estimated at 266 cubic yards. The area is broken out into 3 smaller areas for excavation purposes.

Area A—WasteTron shall excavate approximately 222 cubic yards of material from this area. Dimensions are 50' x 20' by 6'. Primary contaminants are nitroaromatics and lead.

Area B—WasteTron shall excavate approximately 22 cubic yards of material from this area. Dimensions are 10' x 10' by 6'. Primary contaminants are nitroaromatics and lead.

Area C—WasteTron shall excavate approximately 22 cubic yards of material from this area. Dimensions are 10' x 10' by 6'. Primary contaminants are nitroaromatics and lead.

Building 417 Wastewater Settling Tanks. Total remediation volume is estimated at 300 Cubic yards. The area is broken out into 4 smaller areas for excavation purposes.

Area A—WasteTron shall excavate approximately 28 cubic yards of material from this area. Dimensions are 20'x 25' x 1.5'. Primary contaminants are nitroaromatics.

Area B—WasteTron shall excavate approximately 28 cubic yards of material from this area. Dimensions are 20'x 25' x 1.5'. Primary contaminants are nitroaromatics.

Area C—WasteTron shall excavate approximately 63 cubic yards of material from this area. Dimensions are 45' x 25' x 1.5'. Primary contaminants are nitroaromatics.

Area D—WasteTron shall excavate approximately 181 cubic yards of material from this area. Dimensions are 65'x 25' x 1.5'. Primary contaminants are nitroaromatics.

Building 452 Bi-Tri House. Total remediation volume is estimated at 500 cubic yards. The area is broken out into 2 smaller areas for excavation purposes.

Area A —WasteTron shall excavate approximately 417 cubic yards of material from this area. Dimensions are 25'x 45' x 10'. Primary contaminants are nitroaromatics and lead.

Area B—WasteTron shall excavate approximately 83 cubic yards of material from this area. Dimensions are 15'x 15' x 10'. Primary contaminants are nitroaromatics and lead.

Building 453 Fortifier House. WasteTron shall excavate approximately 71 cubic yards of material from this area. Dimensions are 15' x 15' x 10. Primary contaminants are nitroaromatics.

Building 456 Wash House. Total remediation volume is estimated at 241 cubic yards. The area is broken out into 7 smaller areas for excavation purposes.

Area A—WasteTron shall excavate approximately 29 cubic yards of material from this area. Dimensions are 14'x 14' x 4'. Primary contaminants are nitroaromatics.

Area B—WasteTron shall excavate approximately 85 cubic yards of material from this area. Dimensions are 24'x 24' x 4'. Primary contaminants are nitroaromatics and lead.

Area C—WasteTron shall excavate approximately 52 cubic yards of material from this area. Dimensions are 27' x 13' x 4'. Primary contaminants are nitroaromatics.

Area D—WasteTron shall excavate approximately 30 cubic yards of material from this area. Dimensions are 20'x 10' x 4'. Primary contaminants are nitroaromatics.

Area E—WasteTron shall excavate approximately 15 cubic yards of material from this area. Dimensions are 10'x 10' x 4'. Primary contaminants are nitroaromatics.

Area F—WasteTron shall excavate approximately 15 cubic yards of material from this area. Dimensions are 10'x 10' x 4'. Primary contaminants are nitroaromatics.

Area G—WasteTron shall excavate approximately 15 cubic yards of material from this area. Dimensions are 10'x 10' x 4'. Primary contaminants are nitroaromatics.

Northeast Nail House. WasteTron shall excavate approximately 33 cubic yards of material from this area. Dimensions are 15' x 15' x 4'. Primary contaminants are nitroaromatics and lead.

Building 462 Bi-Tri House. WasteTron shall excavate approximately 67 cubic yards of material from this area. Dimensions are 15' x 15' x 8'. Primary contaminants are nitroaromatics.

Building 463 Fortifier House. WasteTron shall excavate approximately 296 cubic yards of material from this area. Dimensions are 40' x 20' x 10'. Primary contaminants are nitroaromatics and lead.

Building 466 Wash House. Total remediation volume is estimated at 753 cubic yards. The area is broken out into 4 smaller areas for excavation purposes.

Area A—WasteTron shall excavate approximately 194 cubic yards of material from this area. Dimensions are 35'x 20' x 7.5'. Primary contaminants are nitroaromatics.

Area B—WasteTron shall excavate approximately 378 cubic yards of material from this area. Dimensions are 45'x 30' x 7.5'. Primary contaminants are nitroaromatics.

Area C—WasteTron shall excavate approximately 167 cubic yards of material from this area. Dimensions are 50' x 20' x 4.5'. Primary contaminants are nitroaromatics.

Area D—WasteTron shall excavate approximately 17 cubic yards of material from this area. Dimensions are 10'x 10' x 4.5'. Primary contaminants are nitroaromatics.

Northwest Nail House. WasteTron shall excavate approximately 78 cubic yards of material from this area. Dimensions are 20' x 30' x 3.5'. Primary contaminants are nitroaromatics.

Building 472 Bi-Tri House. Total remediation volume is estimated at 190 cubic yards. The area is broken out into 2 smaller areas for excavation purposes.

Area A —WasteTron shall excavate approximately 42 cubic yards of material from this area. Dimensions are 15'x 15' x 5'. Primary contaminants are nitroaromatics.

Area B—WasteTron shall excavate approximately 148 cubic yards of material from this area. Dimensions are 20'x 40' x 5'. Primary contaminants are nitroaromatics.

Building 473 Fortifier House. WasteTron shall excavate approximately 83 cubic yards of material from this area. Dimensions are 15' x 15' x 10'. Primary contaminants are nitroaromatics.

Building 476 Wash House. Total remediation volume is estimated at 83 cubic yards. The area is broken out into 2 smaller areas for excavation purposes.

Area A—WasteTron shall excavate approximately 58 cubic yards of material from this area. Dimensions are 35'x 15' x 3'. Primary contaminants are nitroaromatics.

Area B —WasteTron shall excavate approximately 25 cubic yards of material from this area. Dimensions are 15'x 15' x 3'. Primary contaminants are nitroaromatics.

Task 7 Chemical stabilization of excavated soils classified as hazardous waste and subsequent testing of mixed soils prior to disposal.

Task 8 Disposal of Investigation Derived Waste (IDW).

Task 9 Confirmation sampling of each of the excavation pits.

Task 10 Preparation and submission of the Draft and Final Remedial Action Report.

Task 11 Public meeting support will be provided to the USACE for the work defined by this delivery order.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The collection of quality data and the completion of any given project are strongly affected by the project organization. A project that is properly organized with personnel responsibilities well-delineated results in a successful project conclusion. A listing of functional areas and qualified personnel are given for this project.

A. **Government Technical POC** —This is the technical point of contact (POC) representing the USACE who will serve as a liaison between the USACE and the contractor.

USACE POC	Phone Number
Lisa Humphreys	(304) 529-5953

B. **NASA POC**— This is the technical point of contact (POC) representing NASA.

NASA POC	Phone Number
Robert Lallier	(419) 621-3234

C. **Contractor's Project Manager** – WasteTron's Project Manager provides technical insight and provides supervision for the project. The Project Manager has overall responsibility to see that the project is completed in accordance with the Scope of Work.

WasteTron Inc. Project Manager		Phone Number
Steve Arbogast		(304) 755-8448
	Cellular phone	(304) 389-9580

D. **On-site Supervisor**—The On-site Supervisor will be in charge of field activities when the Project Manager is away from the site. It is anticipated that the Project Manager will be on-site for the majority of the project.

On-site Supervisor		Phone Number
Malcolm Slone		(304) 755-8448
	Cellular phone	(304) 633-2373

E. **Site Safety and Health Officer (SSHO)** – The SSHO is responsible for safety on site. The SSHO is an employee of Pinnacle Environmental, a company specializing in safety and health issues.

SSHO	Phone Number
Andrea Thomas	(304) 757-5204

F. **QC Officer**—This person is responsible for quality control (QC) at the site. This person has the authority to stop the work if QC is not being met. The QC Officer shall be responsible for sampling activities and field screening of samples.

WasteTron QC Officer	Phone Number
Senah Gussler	(304) 755-8448

G. **Field Personnel** – These personnel are responsible for assisting the Project Manager in completing the tasks required under this contract.

WasteTron Field Personnel	Phone Number
Dwayne James	(304) 755-8448
Travis Engle	
Gary Henry	
Lynn Moles	
Chester Porter	
Malcolm Slone	

H. **WasteTron's Independent Quality Control Team–** An internal quality control team will independently review the work plans and reports to ensure that they meet requirements of the Scope of Work.

WasteTron Independent Quality Control Team	Phone Number
David Beam	(740) 574-6144
Chris Burke	

I. **REIC Laboratory**–Samples will be sent to the following USACE certified laboratory. REIC Laboratory is located in Beaver, West Virginia.

REIC Contact	Phone Number
Grant Wilton	(800) 999-0105

J. **Disposal Facility for Contaminated Soil**— Non-hazardous soil removed from the site will be disposed of at the Erie County Landfill.

Erie County Landfill	Phone Number
Fred Dobbert	(419) 433-3624

K. **Barnes Nursery**—This company will be used for the transportation of any non-hazardous materials removed from the site. Additionally, this company will transport clean backfill material to the site from their facility.

Barnes Nursery Contact	Phone Number
Leslie Morgan	(800) 421-8722

L. **Mountain State**—Personnel from Mountain State will perform a survey of the 30 areas to be excavated.

Mountain State Contact	Phone Number
Jim Young	(304) 949-4762

M. **Dart Trucking**— In the event that some of the soil does not pass the TCLP test for disposal at the Erie County Landfill then Dart Trucking will be responsible for the transportation of material to EQ Environmental located in Michigan.

Dart Trucking Contact	Phone Number
Bill McCluskey	(800) 541-8206 Extension 192

N. **EQ Environmental**—The hazardous disposal facility for the contaminated soil is EQ Environmental located in Michigan.

EQ Environmental Contact	Phone Number
Debbie Chamberlain	(800) 592-5489

O. **Enviro-Clean Inc.**—Non-hazardous investigation derived waste (IDW) containing liquids will be transported to Enviro-Clean Inc. located in Wooster, Ohio for ultimate disposal.

Enviro-Clean Inc.	Phone Number
Robert Jarrett	(330) 264-8080

P. **Sevenson**—Personnel from Sevenson will perform the soil treatment of the lead impacted soils. The Sevenson Contact is Chuck McPheeters. Mr. McPheeters is not expected to be on-site; however, one or more of the other personnel from Sevenson will be on-site.

Sevenson Contact	Phone Number
Chuck McPheeters	(812) 988-9930
Rance Sundquist	
William Schilling	
Kurt McAllister	

Q. **Eco First**—This company will be responsible for the transportation of any hazardous IDW to EQ Environmental for disposal.

Eco First Contact	Phone Number
Dana Tomes	(304) 736-7303

3.0 APPLICABLE, RELEVANT, AND APPROPRIATE REQUIREMENTS (ARARs)

3.1 Site Remedial Investigation

Remedial Investigation (RI) fieldwork was conducted in 1998 in order to provide a basis for taking an action at the site. As part of the RI, a human health risk assessment was conducted for TNTB. Thirteen constituents of concern (COC) were identified in surface and subsurface soil. Based on the results of the human health risk assessment, it was determined that remedial actions were to be taken to prevent human exposure via any exposure route (ingestion, inhalation, or dermal contact) to soil that exceeds the preliminary remediation goals (PRGs).

Table 1--Chemicals of Concern

Chemical of Concern	PRGs (mg/kg)[1]
Nitroaromatics	
2-amino-4,6-DNT	0.40
4-amino-2,6-DNT	0.40
2,4-DNT	7.50
2,6-DNT	2.75
2-nitrotoluene	74
2,4,6-TNT	3.36
PCBs	
Aroclor 1254	0.16
Aroclor 1260	2.87
PAHs	
Benzo (a) anthracene	5.43
Benzo (a) pyrene	0.54
Benzo (a) fluoranthene	5.43
Dibenz (a,h) anthracene	0.65
Indeno (1,2,3-cd) pyrene	5.43

[1] mg/kg is equal to parts per million (ppm)

3.2 Resource Conservation And Recovery Act (RCRA)

Subtitle C of the federal Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, authorizes EPA to regulate the management of hazardous wastes. The designation of a waste as hazardous subjects all those charged with managing that waste to the stringent "cradle-to-grave" requirements of RCRA Subtitle C. It is crucial, therefore, for all those managing wastes to properly identify them and determine whether or not those wastes are in fact "hazardous". There are four kinds of hazardous wastes as defined by Subtitle C of RCRA:

- Solid wastes, which exhibit hazardous characteristics (i.e., ignitability, corrosivity, reactivity, or toxicity).
- Solid wastes specifically listed by the Agency as being hazardous.
- A waste that is considered a declared waste.
- A waste mixed with a known hazardous waste.

The toxicity characteristic identifies wastes that are likely to leach hazardous concentrations of certain toxic contaminants into groundwater under improper storage conditions. The toxicity of a waste can be determined by applying the toxicity characteristic leaching procedure (TCLP), a test designed to simulate the leaching of toxic constituents. Full TCLP analysis (volatiles, semi-volatiles, metals, herbicides, and pesticides) will be performed on all soil and investigation derived waste (IDW) that is to be removed from the project site. Analytical data from the TCLP analysis will be compared to the RCRA regulatory levels for TCLP constituents.

4.0 FIELD ACTIVITIES

4.1 Borrow Area

Upon approval of the SSHP, QCP and this Plan of Operations, WasteTron will mobilize to the borrow site to collect samples of the borrow material for analysis. The borrow site (located at Barnes Nursery property) is not located at NASA PBS but is located in close proximity; therefore, access to the site will not be necessary for this sampling event. The borrow area will be sampled and analyzed to ensure that the borrow material is not contaminated. Samples will be collected using either an auger and/or an excavator to take samples. It is anticipated that approximately 3300 cubic yards of borrow soil will be needed to fill the 30 excavations. The borrow material will be considered appropriate for use in backfill of excavated pits if all chemical constituents are below the preliminary remediation goals (PRGs) listed in Table 1, Section 3.1 of this plan. Refer to Table 2 in Section 5.1 of this plan for the analytical requirements for the borrow material.

4.2 Storage/Staging Area Preparation

WasteTron will notify the USACE POC and receive approval of the planned project schedule prior to mobilizing to the NASA PBS site. WasteTron will set-up an office trailer on-site to be used by WasteTron and USACE project personnel throughout the duration of the project. A portion of this office will be used as a laboratory for field screening of samples.

WasteTron will begin clearing/grubbing activities for the staging/storage areas. Material grubbed from the staging/storage area will be placed in windrows for wildlife habitat if approved by NASA and USACE. WasteTron proposes to use three areas for storage/staging. One area is proposed for the storage of clean backfill material, one area is proposed as staging area for nitroaromatic contaminated soils, and the last area is a staging area where the lead contaminated soil will be treated. The storage/staging areas shall be constructed using concrete road barriers (Jersey barriers) and three layers of 6-mil plastic. An excavator and/or backhoe will be used to prepare the storage/staging areas with a minor depression to prevent possible problems with run-off from the areas. After the ground is prepared, three layers of 6-mil plastic will be laid down and Jersey barriers would be set around the area with an opening in the front to allow for equipment access. Soils will be covered with plastic, as necessary, to prevent water from storms coming into contact with the stored soils.

Upon confirmation that the borrow soil is appropriate for use, WasteTron proposes to transport approximately 3300 cubic yards of borrow soil into the site and store it for future use. It is anticipated that it will take two to three days to transport all of the borrow material to the site. Upon completion of the project, all soils will be removed (contaminated soils will be disposed and the backfill material will be placed in the excavations) from the three areas and the areas will be seeded and mulched. Refer to the site map in Appendix B for the storage/staging areas.

4.3 Excavation and Disposal of Contaminated Soil

WasteTron shall not perform any intrusive activities at the site until NASA PBS has approved the digging and excavation permits for the site. WasteTron applied for the digging and excavation permits on July 18, 2002.

Prior to excavating any soils, WasteTron will collect a subsurface sample from one of the areas contaminated with lead. This sample will be sent to Sevenson Environmental Services for evaluation to determine the appropriate mixture of MAECTITE® needed to treat the lead contaminated soil. Refer to Section 4.3.1 for a description of the treatment method.

Upon approval of the digging and excavation permits, WasteTron will use a track-mounted excavator to remove contaminated soils. WasteTron intends to excavate all of the areas that have only nitroaromatic contamination first. As the nitroaromatic contaminated soil is removed, it will be transported to the nitroaromatic staging area where it will be sampled for waste characterization purposes and stored until full toxicity characteristic leaching procedure (TCLP) analytical data is obtained. Non-hazardous nitroaromatic contaminated soil will be transported to the Erie County Landfill for disposal. Nitroaromatic contaminated soil that fails the TCLP analysis for any TCLP constituent other than lead may be treated on-site or it may be disposed at EQ Environmental's Wayne Disposal Facility in Michigan. Determining factors for potential treatment on-site will be the amount of soil failing the TCLP analysis, the contaminant(s) of concern type, and concentration of the contaminant(s). Since these are not known, the selection and procedures for a remediation process is not something that can be included in the plans. WasteTron intends to dispose of hazardous soils at a hazardous landfill unless the USACE and/or NASA would want to perform on-site treatment.

After the soil contaminated only with nitroaromatics has been removed, WasteTron will then remove the nitroaromatic and lead contaminated soil. This soil will be transported to the previously prepared staging area, where it will be mixed with MAECTITE® as it is emptied into the storage area. MAECTITE® is being used to chemically bind the lead in the soil so that it will pass TCLP analysis. Samples for waste characterization will be collected from the treated soil approximately 12 hours after the last soil is treated. If the soil passes the TCLP analysis, no further treatment will be necessary. If the soil fails the TCLP analysis, additional MAECTITE® shall be mixed with the soil and the soil shall be re-sampled after 12 hours. Treatment will be performed as necessary until the soil passes TCLP analysis. Non-hazardous soil will be transported to the Erie County Landfill for disposal. Soil that fails the TCLP analysis for any TCLP constituent may be further treated on-site, if appropriate, or it may be disposed at EQ Environmental's Wayne Disposal Facility in Michigan. The soil will be stored on-site until all excavated soils have been characterized and approved for disposal.

Refer to Section 5.3 for the parameters to be analyzed for the disposal of the excavated soil. WasteTron shall collect 1 sample for waste characterization purposes per 150 tons of contaminated soil removed. It is anticipated that a total of 33 soil samples shall be collected for characterization purposes.

4.3.1 Lead Treatment Process

WasteTron will utilize the services of Sevenson Environmental Services Inc. to treat lead contaminated soils at the site. Sevenson has successfully treated heavy metal contamination on various sites. This success in treating RCRA metal-contaminated wastes is attributable to Sevenson's patented MAECTITE® chemical treatment process. Metals and compounds that are successfully rendered non-hazardous by RCRA definition with the MAECTITE® technology include, lead, cadmium, arsenic, chromium, selenium, and barium. The one, two, or three-step MAECTITE® process converts leachable metals into mineral crystal species within the waste matrix, greatly lowering the solubility of the metal in this complexed form. The number of treatment reagent additions is a function of the matrix geochemistry, metal type and valence forms which is determined by Sevenson's evaluation of a soil sample from the site. In the first step a proprietary powdered chemical may be blended with the lead-contaminated material. In the second step a proprietary liquid reagent (MAEPRIC®) is blended into this mixture. An additional oxidation-reduction step may be required for multi-valent metals. Under standard conditions of temperature and pressure, curing takes 3 to 5 hours. Treated materials consistently pass the Paint Filter test, and meet TCLP criteria for characteristic and listed hazardous wastes.

The principle behind the MAECTITE® process is chemical bonding, which creates substituted mixed mineral forms, that are stable and resistant to leaching. Material treated by MAECTITE® contains the metal species as a mineral within the waste matrix. These minerals cannot be degraded by physical forces or other environmental stressors such as chemical conditions present within landfills or associated with acid rain.

5.0 ANALYTICAL REQUIREMENTS

WasteTron will use REIC Laboratory of Beaver, West Virginia to perform the analytical testing for the confirmation and waste characterization samples associated with this project. REIC is a USACE certified laboratory. REIC's detection and quanitation limits are based upon their minimum detection limit (MDL) studies and are specific for each media and the instrumentation that is being used. The laboratory shall follow the most currently promulgated EPA methods.

5.1 Borrow Area

WasteTron shall collect representative samples of the borrow material and have it analyzed for the parameters listed in Table 2.

Table 2—Chemical Analyses of Borrow Material

Analytical Parameter	Number of Samples	Number of QC Samples	Method	Size & Container Type	Preservative	Maximum Holding Time
Target analyte list (TAL) metals	10	1	SW846/3050B, 6010B, 7471A	1 9-ounce glass	Ice 4°C	28 days for mercury, 6 months for other metals
Volatiles	10	1	SW846/8260B	1 9-ounce glass	Ice 4°C, no headspace	14 days
Semi-volatiles	10	1	SW846/8270C	1 9-ounce glass	Ice 4°C	7 days until extraction, analyze within 40 days of extraction
Polychlorinated biphenyls (PCBs)	10	1	SW846/8082A	1 4-ounce glass	cool to 4°C	7 days until extraction; analyze within 40 days of extraction
Total Nitroaromatics	10	1	SW-846/8330	1 9-ounce glass	Ice 4°C	Extract 7 days Analyze 40 days

The borrow material will be considered appropriate for use in backfill of excavated pits if all chemical constituents are below the preliminary remediation goals (PRGs) listed in Table 1, Section 3.1 of this plan.

5.2 Screening and Confirmation Sampling of Excavated Areas

WasteTron shall excavate 30 areas to the horizontal and vertical limits described in Task 6 of the SOW and reiterated in Section 1.2.1 of this plan. Once these limits have been reached, WasteTron shall use field screening for nitroaromatics and lead (where appropriate) to determine if the excavation limits have been reached for each excavation. Once this determination has been made, WasteTron shall collect samples from each individual excavation pit for confirmation analysis for total nitroaromatics and TAL metals, where appropriate. Personnel will not enter the excavation areas to perform sampling. Samples will be collected from the backhoe bucket using a trowel or shovel.

Pursuant to the SOW, one confirmation sample shall be collected from the midpoint of the floor of each excavation and one sample from the midpoint of each of the walls of each excavation for all excavations which have lengths of 20 feet or less. For example, 5 samples would be collected

from an excavation that is 20' x 10' x 4' (1 sample each from both of the 20 foot walls, 1 sample from the floor and 1 sample from each of the 10' walls). For those areas where the length of the excavation exceeds 20 feet, two samples shall be taken along each length (walls and floor) that exceeds 20 feet. For example, 8 samples would be collected from an excavation that is 50' x 20' x 6' (2 samples each from both of the 50 foot walls, 2 samples from the floor and 1 sample from each of the 20' walls). When multiple samples are collected from a single wall or the floor they shall be spaced in such a manner as to be representative of the wall or floor. Multiple samples from a wall and/or floor shall not be taken in close proximity to each other. Refer to Table 3 for the number and type of confirmation samples to be collected from the excavation areas. It should be noted that the number of samples shown may be decreased slightly due to "common walls" being breached at a couple of the excavations which are adjacent to or in very close proximity to each other. For example, Area E at Building 456 has one wall in common with Area D at Building 456. Refer to the site map in Appendix B for the location of each excavation.

Table 3—Number and Type of Confirmation Samples from Excavation Areas

Location	Excavation Size	Sample Number for Total Nitroaromatics	Sample Number for TAL Metals
Building 412—Sweating and Graining House			
A	50' x 20' x 6'	8	8
B	10' x 10' x 6'	5	5
C	10' x 10' x 6'	5	5
Building 452—Bi-Tri House			
A	25' x 45' x 10'	10	10
B	15' x 15' x10'	5	5
Building 463 –Fortifier House	40' x 20' x 10'	8	8
Building 456—Wash House			
A	14' x 14' x 4'	5	0
B	24' x 24' x 4'	10	10
C	27' x 13' x 4'	8	0
D	20' x 10' x 4'	5	0
E	10' x 10' x 4'	5	0
F	10' x 10' x 4'	5	0
G	10' x 10' x 4'	5	0
Building 417—Wastewater Settling Tanks			
A	20' x 25' x 1.5'	8	0
B	20' x 25' x 1.5'	8	0
C	45' x 25' x 1.5	10	0
D	65' x 25' x 1.5'	10	0
Building 453	15' x 15' x 10'	5	0
Northeast Nail House	15' x 15' x 4.5'	5	5
Building 462	15' x 15' x 8'	5	0
Building 466			
A	35' x 20' x 7.5'	8	0
B	45' x 30' x 7.5'	10	0
C	50' x 20' x 4.5'	8	0
D	10' x 10' x 4.5'	5	0
Northwest Nail House	20' x 30' x 3.5'	8	0
Building 472			
A	15' x 15' x 5'	5	0
B	20' x 40' x 5'	8	0
Building 473	15' x 15' x 10'	5	0
Building 476			
A	35' x 15' x 3'	8	0
B	15' x 15' x 3'	5	0

Initially, each of the samples collected from an excavation shall be placed in individually labeled 1-gallon zip lock bags and placed on ice. The zip lock bags shall be properly labeled (i.e. Building 412, Area B, North Wall, 4:15 p.m., August 5, 2002). As few as 5 zip lock bags and as many as 10 zip lock bags will be needed per excavation depending upon the size of the excavated area. If soil from the bags passes the field screening criteria (less than 2.75 ppm for nitroaromatics and less than 100 ppm for lead), then soil will be transferred from each individual

bag to an individually corresponding laboratory supplied sample container and sent to the laboratory for confirmatory analysis. If soil from the bags fails the field screening criteria, then the soil will be added into the soil excavated from the pit, which will be awaiting disposal. The pit will then be over excavated. Samples will again be collected from the midpoint of the walls and floor and placed in individual bags and field screened to determine if the limits of excavation have been met. This process will continue until field screening criteria are met or a decision is made by the Project Manager that confirmatory samples will be sent to the lab because possible interferences exist with the field screening. Under all situations, analytical data from the confirmatory samples sent to the laboratory will be used to determine if the excavation has resulted in the removal of the contaminated soils to below PRGs.

Prior to sending samples to the laboratory for confirmatory analysis, field screening will be performed in hopes that the extent of excavation can be quickly delineated. Samples for field screening will be composited to limit the time and cost associated with the screening. For excavations where only 5 samples are collected (4 walls and the floor), all of the walls will be composited together for one field screening sample and the floor will be tested as a separate sample. If the field screening reveals that no contaminants (nitroaromatics and/or lead) are present above field screening criteria for the composite of the walls and the floor, then confirmatory samples will be sent to the lab. If the floor sample indicates that contamination is above the field screening level, then over excavation of the floor will continue until field screening results show that the contamination is below the screening level. If field screening reveals that the composite sample from the walls is above screening levels, then field screening tests will be ran on each individual wall from the excavation to determine the location of the contamination so that over excavation can be performed.

When performing field screening on excavations where a length exceeds 20 feet, samples will be composited for field testing. An excavation that is 50' x 20' x 6' would require 2 confirmatory samples from each 50' side, 1 from each 20' side, and 2 from the floor for a total of 8 samples. For field screening purposes, the two samples from the one 50-foot wall would be composited together to make one field screening sample for that wall. The two samples from the other 50-foot wall would be composited to make 1 field screening sample and the 2 samples from the 50-foot floor would be composited together to make one floor sample for field screening. The two samples (one from each wall) collected from the 20' walls would be composited to make one field screening sample. Therefore, an excavation that is 50' x 20' x 6' will have 8 confirmatory samples but will have only 4 samples for field screening due to the compositing of the samples for field testing purposes.

5.2.1 Field Screening Methods

Field screening for nitroaromatics will be performed on samples from all 30 excavations. Field screening for lead will be performed on samples from 7 excavation areas. WasteTron proposes to use the TNT EnSys® Soil Test System for field screening of nitroaromatics. The EnSys® system is a colorimetric test kit system that detects various nitroaromatic compounds, but it has a greater sensitivity to TNT, DNT, and TNB than it does to other nitroaromatic compounds. The least detectable concentration that the system can reach is 0.7 ppm but its range is generally reported as from 1 to 30 ppm.

A brief summary of the EnSys® system is as follows. A 10 gram sample of soil is placed in an extraction jar to which 50 milliliters (ml) of acetone is added. The soil and acetone are shaken for 3 minutes to extract the nitroaromatics. After shaking, the mixture is allowed to settle for five minutes and then a syringe equipped with a filter is used to transfer 25 ml of the solution to a sample cuvette. One drop of developer solution is added to the cuvette. The cuvette is then capped and shaken vigorously for 3 seconds. The resulting solution is analyzed using a spectrophotometer to read the absorbance of the solution. The absorbance value is then calculated using a formula provided by Ensys® to determine concentration.

Samples from eight excavation areas will be field screened for lead using the Palintest Scanning Analyzer. The Palintest Scanning Analyzer uses differential pulse anodic stripping voltammetry to detect lead. A 5-gram sample of soil is extracted in an ultrasonic bath with dilute nitric acid. The liquid is decanted into a small tube and a conditioning tablet is added. This tablet provides the correct electrical conductivity for the test samples. A disposable electrode is inserted into the electrode holder and immersed into the sample. In 45 seconds, the scanning analyzer displays the results of the test in micrograms of lead per sample. A simple calculation is then used to convert the reading to milligrams/kilogram, or ppm.

5.2.2 Confirmatory Analysis

Refer to Table 4 below, which specifies the analytical method, sample containers, preservation procedure, and holding time requirements for samples collected for this project.

Table 4—Analysis of Confirmatory Samples

Analytical Parameter	Number of Samples	Number of QC Samples	Method	Size & Container Type	Preservative	Maximum Holding Time
Nitroaromatics	205	20	SW-846/8330	1 9-ounce glass bottle with Teflon lined lid	Ice 4°C	Extract 7 days Analyze 40 days
Target Analyte Metals	56	6	SW846/3050B, 6010B, 7471A	1 9-ounce glass	Ice 4°C	28 days for mercury, 6 months for other metals

5.3 Waste Characterization

Waste characterization for disposal of the contaminated soil and the investigation derived waste (PPE, field test kit waste, and so forth) is required. Toxicity characteristic leaching procedure (TCLP) methods will be utilized to characterize the waste from this site. NASA personnel must sign manifest for all hazardous waste removed from the site. USACE or WasteTron personnel may sign non-hazardous manifests. Holding times for the samples shall not be exceeded. Pursuant to the SOW, one sample per 150 tons of contaminated soil shall be collected for waste characterization analysis. The table below specifies the analytical method, sample containers, preservation procedure, and holding time requirements for samples collected for this project.

Table 5—Chemical Analysis for Waste Characterization Purposes

Analytical Parameter	Number of Samples	Number of QC Samples	Method	Size & Container Type	Preservative	Maximum Holding Time
Contaminated Soil						
Toxicity Characteristic Leaching Procedure (TCLP) metals	33	4	SW846/1311, 6010B, 7471A	250 grams/glass	Ice 4°C	28 days for mercury, 6 months for other metals
TCLP volatiles	33	4	SW846/1311, 8260B	250 grams/glass	Ice 4°C, no headspace	14 days
TCLP semi-volatiles	33	4	SW846/1311, 8270C	250 grams/glass	Ice 4°C	7 days until extraction, analyze within 40 days of extraction
TCLP herbicides and pesticides	33	4	SW846/1311, 8081, 8151	250 grams/glass	Ice 4°C	7 days until extraction, analyze within 40 days of extraction
Flashpoint	33	4	SW846/1030	250 grams/glass	Ice 4°C	7 days
pH	33	4	SW846/9045C	250 grams/glass	None required	7 days
Paint Filter	33	0	SW846/9095A	250 grams/glass	None required	7 days
Investigation Derived Waste						
Toxicity Characteristic Leaching Procedure (TCLP) metals	2	0	SW846/1311, 6010B, 7471A	250 grams/glass	Ice 4°C	28 days for mercury, 6 months for other metals
TCLP volatiles	2	0	SW846/1311, 8260B	250 grams/glass	Ice 4°C, no headspace	14 days
TCLP semi-volatiles	2	0	SW846/1311, 8270C	250 grams/glass	Ice 4°C	7 days until extraction, analyze within 40 days of extraction
TCLP herbicides and pesticides	2	0	SW846/1311, 8081, 8151	250 grams/glass	Ice 4°C	7 days until extraction, analyze within 40 days of extraction
Flashpoint	2	0	SW846/1030	250 grams/glass	Ice 4°C	7 days
PH	2	0	SW846/9045C	250 grams/glass	None required	7 days

6.0 EQUIPMENT DECONTAMINATION

Stainless steel sampling spoons/trowels, a stainless steel mixing bowl, and a backhoe bucket will be used for sampling. Laboratory equipment (pipets, cuvettes, beakers, and so forth), as

appropriate, associated with the field screening will be decontaminated. Also, the stainless steel sampling spoons/trowels, mixing bowl, and backhoe bucket will require decontamination. Stainless steel sampling spoons/trowels will be used to collect samples from the backhoe bucket for the field screening tests and the confirmation sampling. A mixing bowl may be used for sample compositing prior to performing field screening tests.

All non-disposable sampling equipment will be thoroughly cleaned. Decontamination of all of the sampling equipment will be accomplished prior to and between sampling. All decontamination activities for the backhoe bucket will be set up at a temporary decontamination pad. The steps of the decontamination process for the backhoe bucket will be as follows:

- Brush off the backhoe bucket to remove gross contamination
- Wash equipment with soap and water
- Rinse equipment with distilled water

Refer to Table 6 for general decontamination procedures for sampling equipment that will be reused at the site.

Table 6--Decontamination Procedures

Parameter[1]	Detergent Wash	Tap Water Rinse	Inorganic Desorbing Agents	Tap Water Rinse	Organic Desorbing Agents	Deionized Water Rinse	Air Dry
Nitroaromatics	yes	yes	no	no	Hexane	yes	yes

1 No inorganic desorbing agents (hydrochloric acid or nitric acid) will be used for the Total/TCLP metals since we are not looking for trace levels and we will use stainless steel sampling equipment.

In cases of gross contamination on sampling equipment, a tap water wash may first be performed to remove clumps of dirt in order to make the detergent wash more effective. The detergent wash shall be a non-phosphate detergent solution, which will be used with brushing or circulating techniques to remove gross contamination. Potable tap water will be used as a rinse for the equipment. A solvent rinse using hexane will be used as an organic desorbing agent. The analytical laboratory performing the analysis shall be consulted prior to sampling to ensure that decontamination procedures do not affect the subsequent analysis. It is recommended that all solvent rinses be made from an appropriate grade of chemical, such as pesticide or purge-and-trap grade quality. A triple rinse with deionized organic-free water shall follow all other decontamination reagents.

All rinsates will be collected and properly disposed. Drums, buckets, water, detergent, and brushes will be located in the work area. Drums will be available for containerizing the decontamination waste.

6.1 Investigation Derived Waste (IDW)

IDW (PPE, decontamination liquids, waste from field test kits, and all waste/media generated from the investigation activities) from the site shall be disposed in accordance with this Plan of Operations and in compliance with EPA's off-site disposal policy, Resource Conservation and Recovery Act (RCRA) regulations including the RCRA land disposal restrictions for on-site and off-site waste disposal, and the Department of Transportation's (DOT) regulations. WasteTron will arrange for all services necessary for transport and disposal of the waste at an appropriate disposal facility. Analysis of the waste will be performed to identify potential hazardous constituents prior to disposal. Personnel will adhere to the safety procedures as outlined in the Site-Specific Safety and Health Plan. Personnel will wear, at a minimum, Level D PPE when performing waste sampling activities. Representative samples of the IDW shall be collected for characterization prior to disposal and analyzed for the parameters shown in Table 5 of Section 5.3 of this plan.

Waste will not be stored on site longer than 90 consecutive days. Waste from this site will not be combined with waste from another site. All waste will be transported in containers meeting DOT specifications. All drums/containers will be labeled with the project name, contents, and collection start date.

Non-hazardous liquid waste may be transported to the Enviro-Clean Services and non-hazardous solid waste may be disposed at Erie County Landfill. All hazardous IDW will be transported to an appropriate disposal facility (EQ Environmental in Michigan) by Eco-First, a licensed hazardous waste transporter.

WasteTron will be responsible for laboratory analyses and proper disposal of the IDW in accordance with applicable state and federal laws. All non-hazardous manifest will be provided to the USACE for signature and all hazardous manifest will be provided to NASA for signature prior to disposal. WasteTron will provide the USACE with the following documentation concerning the disposal of all IDW from the site:

- Laboratory analysis
- Copies of waste profiles which include land disposal restriction notifications
- Signed manifests (hazardous and non-hazardous)
- Weigh slips for bulk transport

7. 0 FIELD DOCUMENTATION PROCEDURES

The following sections outline the standard practices and procedures for proper documentation of activities for this project. Standard documentation required on all USACE projects, including daily reports and field logs will be completed by the Project Manager.

7.1 Field Logbook/Field Activity Forms

A bound notebook will be maintained by the field crew to provide daily records of significant events, observations, and measurements during field investigations. In addition, field records

will be maintained regarding the various aspects of the sampling. All pertinent information regarding the site and sampling procedures must be documented in indelible ink. Notations should be made in logbook fashion, noting the time and date of all entries. The field records should include the following information:

- Site Location
- Project Number or Work Order Authorization
- Name and title of author
- Names and responsibilities of field personnel on site
- Names and titles of site visitors
- Sampling location and number of samples taken
- Sample description (color, odor etc.)
- Sample collection method and sample preservation methods
- Sample ID numbers
- Dates and times
- Matrix of sample
- Photograph logs
- Sampling changes, modifications or change orders
- Weather conditions
- Other applicable comments

7.2 Photographs

Photographs will be taken of all site activities. For each photograph taken, the following items should be noted in the field logbook:

- Date and time
- Photographer (signature)
- Name of site/Project number
- General direction faced and description of the subject taken

7.3 Sample Identification Labeling

Sample labels are required to properly identify the samples. All samples will be labeled in the field and care will be taken to assure that each sample container is properly labeled. The samples will be placed in sealed plastic bags to prevent the labels from soaking off or becoming illegible from exposure to water during transport to the laboratory. Labels will contain the following information:

- Site location and project number
- Sample Identification number assigned in accordance with the Scope of Work
- Description of the sample
- Time and date sample was taken

- Notation of whether preservatives were added to the sample and type of preservative
- Type of sample (such as a grab or composite)
- Type of analysis requested

All field documentation should be done in indelible ink. Errors in field sampling documents will be corrected by drawing a single line through the error, writing in the correction, and initialing and dating.

7.4 Chain-of-Custody

Chain-of-custody procedures provide documentation of the handling of each sample from the time it is collected until analysis is completed. Chain-of-custody procedures are implemented so that a record of sample collection, transfer of samples between personnel, sample shipping, and receipt by laboratory that will analyze the sample is maintained. The chain-of-custody record serves as a legal record of possession of the sample. To simplify records and eliminate potential litigation problems, as few people as possible should handle the samples during the investigation. A sample is considered to be under custody if one or more of the following criteria are met:

- The sample is in the sampler's possession.
- The sample is in the sampler's view after being in possession.
- The sample was in the sampler's possession and then was locked up to prevent tampering.
- The sample is in a designated secure area.

A chain-of-custody should be filled out on-site and shall include the following information:

- Project number
- Project manager
- Site location
- Client contact
- Description of the sample
- Time and date sample was taken
- Notation of whether preservatives were added to the sample
- Type of preservative
- Type of sample such as a grab or composite
- Matrix of sample
- Amount of sample being transported to the laboratory
- Sample number or ID assigned in the field
- The appropriate analytical parameters to be tested
- Seals shall be placed on each sample containers (except VOCs)
- Any other information that the sampler feels is pertinent to the analysis of the sample(s).

The sampler must sign the chain-of-custody and all sample containers will be transported with a chain-of-custody form. Shipping containers will be sealed for shipment to the laboratory. The original chain-of-custody form will accompany the shipment and WasteTron will retain copies. A sample chain-of-custody form is located in Appendix C.

7.5 Corrections to Documentation

All original data recorded in field logbooks, on sample labels, and chain-of-custody records are to be written in indelible ink. If an error is made on any document related to this project, corrections should be made by drawing a single line through the error and entering the correct information. The erroneous information will not be obliterated. Any error discovered on a document should be corrected by the person who made the entry. All corrections will be initialed and dated.

8.0 SAMPLE PACKING AND TRANSPORTATION

The following are procedures for packaging and shipping of samples for this project:

- All containers, except the volatile organic analysis (VOA) vials, will be taped shut.
- All samples will be chilled immediately after collection.
- Each sample container will be placed in a separate plastic bag and sealed. As much air, as possible will be squeezed from the bag prior to sealing. Bags will be sealed with evidence tape or custody seals.
- A picnic cooler will be used as the shipping container. In preparation for shipping samples, the drain plug on the cooler will be taped shut from the inside and outside, and a large plastic bag will be used as a liner for the cooler. Inert packing material will be placed in the bottom of the liner.
- The sample containers will be placed upright in the lined picnic cooler in such a way that they do not touch and will not touch during shipping.
- All samples will be shipped to the laboratory on ice and chilled to 4 °C.
- Plastic ice packs or ice placed in double plastic bags will be placed around, among, and on top of the sample containers.
- The paperwork going to the laboratory will be placed inside a sealed plastic bag, which will be taped to the inside lid of the cooler.
- The cooler will be taped shut with strapping tape.
- At least two signed custody seals will be placed on the cooler (one in front, the other on the side).

9.0 CONTRACTOR CHEMICAL QUALITY CONTROL

9.1 Data Quality Objectives

The process of generating useful chemical data of acceptable quality begins with determining what the objectives of collecting the data are, and what decisions will be made based on the data that is generated. Next, the actual type of data that is required to meet these objectives is determined, along with the appropriate data collection methodologies and quality control

procedures. The methodologies for collecting quality data must be consistent with accepted practices and standard operating procedures that have been developed for the specific type of data collection to insure quality chemical data. Generally, these steps have been predetermined by the USACE for this project and are delineated in the Scope of Work.

Quality controls are incorporated into both the sample collection and analytical procedures. Quality controls utilized in sample collection include, but are not limited to, following the approved plans and procedures for sample collection, proper documentation of sample collection activities and site conditions, reporting and resolving any problems during sampling activities, and proper handling, preserving, packaging, and shipment of samples. In addition, quality control samples (duplicates and trip blanks) are collected to check the accuracy, completeness, precision, and comparability of the actual field samples. The contract analytical laboratory will follow its internal quality control procedures to insure analytical data quality. The laboratory will use the precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) defined below to insure that their internal quality control objectives have been successfully met.

After the samples have been analyzed and the data reports have been generated, the resulting data will be reviewed, and compared. To assess the quality of the field activities, quality control samples (i.e. duplicates, trip blanks, matrix spikes) will be evaluated for completeness and duplicate relative percent differences (RPDs). The calculation of RPDs from field sample and field duplicate sample data indicates the precision of the sampling efforts as well as the sample media. RPDs are calculated by the following equation:

$$RPD = (C_f - C_d)/\{(C_f + C_d)/2\} X\ 100$$

Where C_f is the concentration of the compound found in the field sample and C_d is the concentration of the compound found in the field duplicate (QC) sample. The RPDs should equal 35% or lower for soils to indicate homogeneity of the sample and the reproducibility of the analytical data (a measure of precision). If the data does not meet the desired RPDs it may be necessary to re-analyze the samples in question, or re-sample if problems cannot be resolved. Decisions to re-analyze or to re-sample will be made with the joint input of the USACE, WasteTron, and the contract laboratory. In this process the PARCCS of the data will be evaluated and a joint determination of the data quality will be made accordingly.

Once all data has been received and analyzed in accordance with the above requirements, the results and recommendations will be forwarded onto USACE. The USACE will then use this information to make decisions regarding specific properties as they relate to project implementation.

The laboratory will use the following PARCCS to insure that their internal quality control objectives have been successfully met.

- Accuracy: This is the degree to which a measurement agrees with the actual value. The accuracy of an analytical procedure is determined by addition of a known amount of spike standard to a field sample matrix or a laboratory control matrix.

- Precision: This is a measure of the degree of reproducibility of an analytical value and it is used as a check of the quality of the sampling and analytical procedures. Precision is determined by analyzing replicate samples. Duplicate samples will be collected in the field for this project.

- Completeness: Completeness is a measure of the amount of the data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. The minimum level of completeness expected is 95% for each analytical method requested. This level is met in the laboratory by ensuring proper sample extraction procedures. This level is met in the field by collecting enough sample that the laboratory has an ample amount in case they need to reanalyze the sample.

- Representativeness: Representativeness expresses the degree to which sample data accurately and precisely represents actual conditions. Representativeness is a qualitative determination. The representativeness objective of the quality assurance program is to eliminate conditions that may result in non-representative data. Maintaining sample integrity is of the utmost importance.

- Comparability: Comparability is the confidence with which one data set can be compared with another. When traceable standards and standard methodology are used, the analytical results can be compared to other laboratories with similar operating procedures. Quality Assurance samples will not be collected for this project.

All field activities will be performed in accordance with the protocols outlined in this Plan of Operations. Samples will be kept in ice filled coolers until they are shipped via overnight express or hand delivered to the laboratory.

9.2 Lab Quality Assurance (QA) for Chemical Data Measurement

The overall QA objective is to ensure that data of known and acceptable quality is generated from both field and laboratory activities. REIC will be responsible for ensuring that their personnel adhere to their laboratory Quality Assurance Plan (QAP). The number and types of internal QC checks for each analytical method are defined in the laboratory's QAP, which is

contained in Appendix D. The laboratory must follow the quality objectives for precision, accuracy, representativeness, comparability, completeness, and method detection limits as set forth in their laboratory QAP. The USACE QA laboratory will be responsible for ensuring that their personnel adhere to their laboratory Quality Assurance Plan (QAP).

All data generated from the chemical analysis will be reported in accordance with the Scope of Work. Any sample failing the method or laboratory quality control limit may be re-analyzed. The analytical laboratory, WasteTron, and the USACE will jointly make the decision regarding re-analysis. Internal QC results should include information about agreement between replicate analyses, spike and surrogate recoveries.

The Remedial Action Summary Report shall include analytical results and a Level 2 Quality Control data report from the laboratory. The Level 2 data package shall include the following:

- Case Narrative-Information should include number and type of samples received, analysis of those samples, any problems that occurred, whether quality control was within acceptable limits, etc.
- Analytical Report-Summary of all sample analysis information including surrogates for organic methods. Detection limits/reporting limits shall be included
- Chain-of-custody
- Summary of Quality Control-A summary shall be included of all quality control specific to the project. This may include method reagent blanks, midlevel calibration checks, spike and spike duplicates. All QC shall include acceptance criteria and relative percent data where applicable.

9.3 Field Quality Control (QC) for Chemical Data Measurement

Field quality control is as vital to a project as is quality control within the laboratory. Proper execution of each project task is needed in order to yield consistent reliable information that is representative of the media and conditions being measured. The overall quality assurance objective is to ensure that data of known quality is generated so that it will be useful in meeting the intended project objectives. The Project Manager will be responsible for seeing that field personnel (WasteTron and subcontractors) adhere to WasteTron's QCP.

QC field oversight checklists to be used for field activities are provided in Appendix C. The field oversight checklists should be completed for each project site. The Project Manager shall provide an explanation on the QC field oversight sheets for any items that he marks were not completed. The Project Manager will review the following items with the field crew prior to beginning on-site operations.

- Contract Specifications
- Contents of this Plan of Operations
- Contents of Site-Specific Safety and Health Plan
- Contents of Quality Control Plan
- Field equipment to be used at project sites

- Sample collection equipment
- Labeling for sample containers
- Chain-of-custody forms
- Laboratory information
- Proper preservation methods for samples
- Proper packaging and shipping procedures for samples
- Proper equipment decontamination procedures
- Proper use of field screening and/or field monitoring equipment

10.0 DAILY QUALITY CONTROL REPORTS (QCR)

During the field investigation and excavation activities, daily Quality Control Reports (QCR) will be prepared daily, dated, and signed by the On-site Supervisor or the QC Officer. WasteTron will utilize the USACE QCR Report Form (see Appendix C). The following information will be recorded on the QCR:

- Weather information
- Field instrument measurements
- Departures from the approved plans (any deviation that may affect data quality objectives must be conveyed to the USACE immediately)
- Personnel on-site and their job activities
- Any problems encountered
- Instructions from government personnel

11.0 CORRECTIVE ACTION

Corrective action measures may be required to be taken in the event a discrepancy is discovered in the field, during an audit, and/or the laboratory discovers a discrepancy or problem. Laboratory discrepancies, unrelated to field procedures, will be addressed by the laboratory's personnel and will be corrected in accordance with their QAP.

Any deviations from the approved plans shall be fully documented. The USACE shall be notified of deviations from the approved plans. Deviations from the plans that compromise data quality or personnel safety shall not be allowed.

12.0 SPILL PREVENTION, CONTAINMENT, AND COUNTERMEASURE PLAN

In cases of spills it is very important to make sure that the area is secured and that the situation is assessed quickly. Ventilation, vapor suppression, and dust suppression may be required prior to cleaning up a site. Trained personnel shall clean up spills quickly unless safety reasons prevent it. All of WasteTron's personnel on-site have been trained in emergency response and clean-up operations. The Project Manager/On-site Supervisor will immediately inform the USACE and NASA POCs of any spills, regardless of the spill location. Additionally, it may be appropriate to contact the Ohio EPA, Northeast District Office (330-963-1200) after contacting the USACE and NASA POCs.

12.1 Potential Spills

Potential sources for spills on this project are:

- Spills or leaks of decontamination liquids from equipment decontamination activities.
- Spills or leaks of decontamination liquids from personnel decontamination activities.
- Petroleum leaks from trucks or heavy equipment used at the site.
- Spills of chemicals (acetone, nitric acid, Tornado-50 cleaner, hexane, MAECTITE®) used on site. It should be noted that only small amounts (1-2 gallons each) of acetone, nitric acid, Tornado-50 cleaner, and hexane will be used on-site. The MAECTITE® will be brought into the site as it is being used; therefore, storage of the material on-site is not anticipated at this time.

Material Data Safety Sheets (MSDS) for the products that may be brought onsite will be posted at the site. Chemicals/petroleum products will not be stored onsite without a current MSDS being provided and kept onsite. At this time, WasteTron does not intend to store diesel, motor oil, antifreeze, or any other petroleum product on-site. The following is a list of the materials anticipated to be stored on-site.

- Acetone
- Tornado-50 cleaner
- Hexane
- Dilute nitric acid
- PPE and small amounts of lab waste (less than 5 gallons of lab waste)

12.2 Spill Prevention

This plan represents a written commitment by WasteTron to supply the manpower, equipment, and materials required to expeditiously control and remove any potential harmful spills that may occur at the NASA PBS site due to project activities. The following are spill prevention procedures that will be implemented at the site:

- All drums used to store liquids that would be harmful to the environment if spilled will be checked on a weekly basis. The Site Supervisor will perform the weekly inspections.
- Heavy equipment (trucks, excavators, etc.) shall be inspected daily prior to use to ensure that they are not leaking.
- A secure area will be used for the storage of decontamination fluids.
- Personnel will be instructed as to their particular requirements as described in this Spill Control Plan

12.3 Spill Response

In the event of a spill or a leak, site personnel will:

- Inform the Project Manager, Steve Arbogast, immediately. Mr. Arbogast will then immediately inform the USACE of any spills, regardless of the spill location and/or amount. In the event that the Project Manager is not on-site the On-site Supervisor shall be informed of any spills.
- All nonessential personnel will be cleared from the area. Personnel trained in emergency response and spill control measures will be utilized to contain any spillage of materials.
- Personnel will isolate the area.
- If spill occurs outside of the exclusion (hot) zone, then personnel must designate the spill area as an exclusion zone to limit potential exposure to onsite personnel.
- Trained personnel will attempt to locate the source of the spillage and stop the flow if it can be done safely.
- Trained personnel will begin containment and recovery of the spilled materials.
- PPE required during spill response for this project will at a minimum be Level D PPE. Level C or higher PPE may be used if spill conditions so warrant.
- Spill clean up shall be performed only by personnel who are trained with spill response procedures.
- Material safety data sheets (MSDS) shall be posted for any potential hazardous materials that are expected to be encountered or used.
- Spills will be reported to the USACE and NASA POCs. If appropriate, the Ohio EPA, Northeast District Office (330) 963-1200 and the National Response Center (800) 424-8802 may be notified.
- Fire extinguishers will be available on-site and ready for use.
- This Spill and Emission Control Plan will be posted at the site

12.4 Spill Containment

Spill containment equipment will be located on-site. Materials used for cleanup shall be placed in drums for proper disposal according to appropriate state and federal regulations. Spill containment material that will be on-site is:

- Absorbent pads, booms, or rolls (sufficient number to absorb a minimum of 200 gallons of spilled liquids)
- Drums containing IDW waste or other materials will be stored within in a lined dike area capable of containing any spills or leaks.

The following are requirements for handling drummed materials on-site:

- All drums and containers used will meet DOT, OSHA, and EPA regulations for the waste that they contain.
- Drums and containers will be inspected and their integrity assured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions, shall be positioned in an accessible location and inspected prior to further handling.
- Operations for the site will be organized so as to minimize the amount of drum or container movement.

- Employees involved in the drum container operations shall be warned of the hazards associated with the containers.
- Where spills, leaks or ruptures may occur, adequate quantities of spill containment equipment (absorbent, pillows, etc.) will be stationed in the immediate area.
- Drums or containers that cannot be moved without failure shall be emptied into a structurally sound container.

12.5 Spill Reporting

WasteTron personnel are to immediately report any imminent or actual spills to the WasteTron Project Manager and/or On-site Supervisor. The Project Manager/On-site Supervisor will then report immediately to the USACE. The USACE will report the information to any regulatory agencies or authorize the Project Manager to do so if the spill amount is reportable. If appropriate, the Ohio EPA, Northeast District Office (330) 963-1200 and the National Response Center (800) 424-8802 may be notified. It is of great importance for personnel to gather the following information if they encounter an imminent or actual spill.

- The location of the release or imminent release.
- The name and quantity of the material involved, to the extent known.
- The possible source or cause of the release.
- The date and time of the release.
- A description of any emergency response actions taken or currently being taken by others.

After the cleanup of a spill, the Project Manager will investigate to determine the possible cause of the spill. The Project Manager shall implement corrective actions to prevent a reoccurrence of the spill.

12.6 Contingency

In the event that on-site field personnel cannot handle the spill, WasteTron Inc. will dispatch their Emergency Response Team. The Emergency Response Team has been trained and has sufficient equipment to perform spill clean up for this project.

13.0 PROTECTION OF RIVERS, STREAMS, AND IMPOUNDMENTS

13.1 Erosion and Silt Control

WasteTron shall exercise every reasonable precaution throughout the life of the project to prevent silting of ditches and streams at the site. Erosion and silt control measures shall include, but is not limited to, the following:

- Prior to suspension of excavation operations for any appreciable length of time, WasteTron shall shape the top of earthwork in such a manner as to permit the runoff of rainwater and shall construct earth berms along the top edges of embankments to intercept runoff water. The berm construction shall not be permitted to decrease the stability of the embankment section.

- Preventive measures taken to adequately control any run-off or run-on of water to excavation areas or to the storage/staging areas. Should such preventive measures fail and an appreciable amount of material begins to erode into a waterway, WasteTron shall act immediately to bring the silt under control.
- Excavated soil shall not be deposited in or so near to waterways that it will be washed away by high water or runoff.
- Diversion ditches will be constructed around areas where running or standing water is present. Currently, two such areas have been identified. Excavation of Area C at Building 417 runs through a drainage ditch and Area G at Building 456 is in a culvert beside the road. Both of these areas will required diversion ditches around them to prevent infiltration of water.

14.0 AIR EMISSION CONTROLS

If necessary, water will be used for dust control in areas of excavation and on haul roads. The Project Manager/On-site Supervisor and the QC Officer will make visual observations of dust levels to determine if water suppression is necessary and/or working.

15.0 PROJECT SCHEDULE

The proposed project schedule is as follows:

Submission of 10 copies of the Draft Site-Specific Safety and Health Plan (SSHP), the Draft Quality Control Plan (QCP), and the Draft Plan of Operations	July 29, 2002
Submission of six copies of the Final SSHP, QCP, and Plan of Operations	5 days after receipt of comments but prior to beginning intrusive fieldwork
Submission of Draft Remedial Action Summary Report	120 days after notice to proceed
Submission of Final Remedial Action Summary Report	150 days after notice to proceed

16.0 REFERENCES

The following reference materials were used in compiling the information contained in this SSHP and/or will be used in other documents associated with this project.

EM-200-1-3, "*Requirements for the Preparation of Sampling and Analysis Plans,*" U.S. Army Corps of Engineers, February 2001

EM-200-1-6, "*Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste Projects (HTRW),*" U.S. Army Corps of Engineers, October 1997

ER-1110-1-263, "*Chemical Data Quality Management for Hazardous Waste Remedial Activities,*" U.S. Army Corps of Engineers, April 1998

CELRHR 5-2-7, "*Quality Management Plan,*" U.S. Army Corps of Engineers, May, 1999

ER 385-1-92, "*Safety and Health Document Requirements,*" U.S. Army Corps of Engineers, March 1994

EM 385-1-1, "*Safety and Health Requirements Manual,*" U.S. Army Corps of Engineers, September 1996

EM 200-1-2, "*Technical Project Planning Process,*" U.S. Army Corps of Engineers, August 1998

EM 200-1-1, "*Validation of Analytical Chemistry Labs,*" U.S. Army Corps of Engineers, July 1994

ER 1165-2-132, "*HTRW Guidance for Civil Works Projects,*" U.S. Army Corps of Engineers, June 1992

Appendix A Scope of Work

Scope of Work for the
Stabilization, Excavation and Disposal of Contaminated Soil
Plum Brook Ordnance Works - TNT Area B
Sandusky, Ohio
Contract No. DACW69-D-00-0021, Work Order No. ____
March 2002

1.0 Introduction.

The purpose of this Scope of Work is for the completion of a Non-time Critical Removal Action within TNT Area B of the Plum Brook Ordnance Works (PBOW) Project. The United States Army Corps of Engineers (USACE) is the responsible authority under the Defense Environmental Restoration Program (DERP) at the former TNTB. Based on the results of the completed Remedial Investigation/Feasibility Study (RI/FS) for soils, the USACE will conduct a Non-Time Critical Removal Action (NTCRA) in TNT Area B. The removal action will be taken to prevent human exposure to site soil containing any of the 12 constituents of concern (COCs) at concentrations that exceed remediation goals. The remediation goals are chemical- and receptor-specific risk based remedial criteria that capture all the exposure assumptions and toxicological data used in the risk assessment. The removal action will consist of the excavation of approximately 3,300 cubic yards of material, backfilling of the excavation pit with clean material, ex-situ stabilization of the excavated material, and off-site disposal of stabilized waste.

1.1 Site History and Location.

The site of the former Plum Brook Ordnance Works (PBOW) is located approximately 4 miles south of Sandusky, Ohio and 59 miles west of Cleveland, Ohio. Although primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is bounded on the north by Bogart Road, on the south by Mason Road, on the west by County Road 43, and on the east by U.S. Highway 250. The surrounding area is mostly agricultural and residential.

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 at PBOW began in December 1941 and continued until 1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during the 4-year operating period. The three explosive manufacturing areas were designated TNT Area A (TNTA), TNT Area B (TNTB), and TNT Area C (TNTC). Twelve process lines were used in the manufacture of TNT, four lines at TNTA, three lines at TNTB, and five lines at TNTC. This SOW deals primarily with the TNTB area.

The TNTB manufacturing site consisted of widely scattered buildings of wood frame construction with asbestos and sheet metal coverings. It also included a series of buried and/or overhead flumes and pipes used to transport various liquids associated with the manufacturing process.

After plant operations ceased, TNTB's manufacturing lines were decontaminated by the War Department in late 1945. During decontamination, all structures, equipment, and manufacturing debris were either removed and salvaged or removed and burned. After decontamination 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). In 1955, GSA completed further decontamination of TNTB. This effort supposedly focused on surface contamination detected by visual inspection. It is unknown whether the underground flumes were addressed by this decontamination effort.

The National Aeronautics and Space Administration (NASA) acquired the property on March 15, 1963 and currently utilizes the site. GSA performed further decontamination efforts during 1963 to facilitate this transfer. The decontamination process included removing contaminated surface soils above the drain tiles, flumes, etc., destruction of all buildings by fire, then removal of all soil, debris, sumps, and concrete foundations. All materials, including the soil in those areas, were flashed; the area was then rough graded. The decontamination process also included the burning of excavated nitroaromatic-filled flumes.

NASA currently operates the Plum Brook Station (PBS) of the John Glenn Research Center at Lewis Field. Most of the aerospace testing facilities built in the 1960s at the site are in standby or inactive status. On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. The Perkins Township Board of Education acquired 46 acres of the excess acreage and uses this area as a bus transportation area. GSA retains ownership of the remaining excessed acreage and currently has a use agreement with the Ohio National Guard for 604 acres of this land. NASA presently controls approximately 6,400 acres and is using the site to conduct space research as a satellite operation of the John Glenn Research Center at Lewis Field in Cleveland, Ohio. The details of land transactions are listed in the site management plan (ICI, 1995) and can be found at the NASA PBS.

TNTB consists of an area of approximately 55 acres at the south-central portion of PBOW immediately north of West Scheid Road. Significant evidence of former PBOW facilities exist at TNTB in the form of roads, hydrants, and ditches; all buildings and structures associated with the manufacturing process have been demolished and removed. Two NASA facilities are present at the site and are currently active for research purposes, the Hypersonic Tunnel Facility (HTF) and Nitrogen Dewar Tanks. The HTF is located in the northwest portion of TNTB and consists of a single building, above and below ground piping and utilities, and paved parking areas. The Nitrogen Dewar Tanks are located in the center of TNTB with aboveground piping and underground utilities leading to the northwest, toward HTF, and to the northeast, offsite.

1.2 Proposed Action Description

To provide a basis for taking an action at this site, Remedial Investigation (RI) fieldwork was conducted in 1998. As part of the RI, nitroaromatic field screening analysis involved the collection of 391 soil samples. To supplement the on-site screening analysis, 40 confirmation soil samples were collected for standard laboratory analysis using SW-846 Method 8330 with second column confirmation. A human health risk assessment was conducted for TNTB. Twelve constituents of concern (COC) were identified in surface and subsurface soil. Five of those COCs are nitroaromatics (2-amino-4,6-dinitrotoluene (DNT); 4-amino-2,6-DNT; 2,6-DNT; 2,4-DNT; and 2,4,6-TNT) and are clearly site related. The remaining seven COCs are polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAH). Lead, which was not listed as one of the COCs, was also found at various levels, and if encountered, will need to be disposed of accordingly.

The proposed approach for this removal action is to excavate all the areas in which the concentration of the COCs in soil exceed the PRGs. The estimated volume of contaminated soil from all over TNTB is 3,300 cubic yards. Following excavation of the contaminated soil, representative soil samples from each area will be analyzed using the TCLP test. Using existing soil data, the estimated volume of excavated soil that may be classified as hazardous waste based on 2,4-DNT concentrations in the extract is about 560 cubic yards. An additional 400 cubic yards of material might be identified as a hazardous waste due to the high lead levels. Based on the results of the TCLP tests, non-hazardous waste would be disposed of in an off-site, non-hazardous waste landfill. Any soil identified as hazardous waste would be treated (i.e., stabilized) to achieve non-hazardous waste classification prior to land disposal in a non-hazardous waste landfill.

Based on the results of the human health risk assessment, the following remedial action objectives (RAOs) were selected for soil. No RAOs were developed for groundwater because groundwater will be evaluated on a sitewide basis at a later date:

"Remedial Actions will be taken to prevent human exposure via any exposure route (ingestion, inhalation, or dermal contact) to site soil containing any of the 12 COCs at concentrations that exceed preliminary remediation goals. Preliminary remediation goals are chemical- and receptor-specific risk-based remedial criteria that capture all the exposure assumptions and toxicological data used in the risk assessment."

Use of the following PRG levels has been approved for project clean-up:

Chemical of Concern	PRGs (mg/kg)
Nitroaromatics	
2-amino-4,6-DNT	0.40
4-amino-2,6-DNT	0.40
2,4-DNT	7.50
2,6-DNT	2.75
2-Nitrotoluene	74
2,4,6-TNT	3.36

Polychlorinated Biphenyls	
Aroclor 1254	0.16
Aroclor 1260	2.87
Polynuclear Aromatic Hydrocarbons	
Benzo(a)anthracene	5.43
Benzo(a)pyrene	0.54
Benzo(a)fluoranthene	5.43
Dibenz(a,h)anthracene	0.65
Indeno(1,2,3-cd)pyrene	5.43

Assuming a successful treatability study, chemical stabilization would be used to treat the excavated soil classified as hazardous waste. A mix box on-site would be used to mix stabilizing agents with the contaminated soil. Representative samples of the stabilized soil would be taken for every 150 tons of processed soil. The samples would be tested for hazardous characteristics using the TCLP test. If the soil tests non-hazardous, it will be disposed in a non-hazardous waste landfill. If the soil tests hazardous, further stabilization would be needed or an alternative treatment would be required.

Since stabilization only alters the physical availability of the contaminants, using stabilized material as backfill at the site is prohibited. Therefore, clean fill material will be placed in the excavation pits, rough graded as necessary to achieve proper drainage, and reseeded.

2.0 Objectives.

The Contractor shall provide all equipment, labor, materials and supervision necessary for the remediation of the TNT Area B site. Remediation activities consist of excavation, stabilization (if necessary) and disposal of contaminated soil and backfill with clean material. Overall, this work shall consist of the following tasks:

Task 1	Preparation/Submittal of a Site-Specific Safety and Health Plan (SSHP)
Task 2	Preparation/Submittal of a Quality Control Plan (QCP)
Task 3	Preparation/Submission of a Plan of Operations
Task 4	Field Activities/Utilities
Task 5	Site Survey
Task 6	Excavation
Task 7	Stabilization
Task 8	Disposal/IDW

Task 9	Confirmation Sampling
Task 10	Preparation/Submission of Draft and Final Remediation Report
Task 11	Public Meeting Support

3.0 Tasks. The tasks outlined in Section 2.0 are described in detail in the following sections of this Scope of Work (SOW). This work shall be conducted by the Contractor in an environmentally acceptable manner conforming to existing federal, state, and local regulations under US Army Corps of Engineers (USACE)/Huntington District (CELRH) supervision.

3.1 (Task 1) Preparation and Submission of the Safety and Health Plan

The initial SSHP has already been developed to cover past mowing, maintenance and monitoring activities. Therefore, that SSHP shall be utilized and updated to cover present activities as outlined in this SOW. The plan shall establish site-specific standard operating procedures to ensure the safety of contractor personnel involved with the field activities. A Job Hazard Analysis (JHA) shall be prepared as part of the SSHP. The SSHP shall also provide for the protection of the general public and the environment. The plan shall comply with the requirements of the U.S. Army Corps of Engineers, Safety and Health Requirements Manual, EM 385-1-1, September 1996, and the Department of Labor, Occupational Safety and Health Administration (OSHA) as presented in Title 29 of the Code of Federal Regulations, Part 1910.120. As a minimum, the contractor SSHP shall address the following items:

- Cover sheet. Identify company name, contract number, project location, signed and dated by plan developer.
- Responsibilities and lines of authority.
- Employee qualifications. Physical fitness, job competence, special skills, equipment operation.
- Employee training. First aid, CPR, back injury prevention.
- Safety meetings. "Tool box" meetings.
- Job Hazard Analysis. Preparation and revision, discussion with employees.
- Emergency response plan. Emergency number, means of communication, route to nearest medical facility.
- Accident reporting and supervisor responsibility. Report all accidents immediately to the Contracting Officer and submit ENG Form 3394 within two (2) working days.
- First aid kits.
- Personal protection equipment. As a minimum, employees must wear long-legged trousers, sleeved-shirt, and steel-toes shoes. Safety glasses with side shields and hard hats may also be appropriate, depending on activity.
- Hearing Protection
- Vehicles and equipment.
- Public safety.

- Fire safety.
- Environmental hazards.
- Housekeeping.
- Standard operating procedures.

The contractor shall read and conform to the SSHP when conducting this work. Documentation to this effect shall be furnished to the Government POC prior to initiation of any work. The plan shall also include the names, and qualifications of the Site Safety and Health Officer, including education, training and work experience.

3.2 (Task 2) Preparation and Submission of the Quality Control Plan

Prior to initiating any field activities, a Project Specific Quality Control Plan (QCP) shall be prepared and implemented by the Contractor as part of this work order. The QCP shall apply to all tasks/activities and products contained in this SOW. The QCP shall be prepared according to CELRHR 5-2-7, Quality Management Plan, ER 1110-1-2, Engineering and Design Quality Management, CELRDC 5-1-1 Quality Management Plan and the applicable ISO 9000 processes developed for this type of work.

The QCP shall define the responsibilities and roles of each member on the Independent Quality Control Team (IQCT), along with those preparing or performing the tasks/activities in this SOW. An example of a QCP shall be provided to the Contractor to aid in his/her generation of the Project Specific QCP.

The QC Plan shall also detail the methods and procedures for inspection of work, identifying and correcting deficiencies, maintenance of records, list of authorized Quality Control Inspectors, list of authorized Contractor representatives, and security measures.

The draft and final versions of the various plans shall include a separate QC appendix that includes an activity review checklist (appropriate checks on those activities that were performed/reviewed) for the specific product, along with a signed sheet which designates the name, date and official work title of those persons performing/conducting the QC activities. All comments and responses, from both the Contractor's QC review and USACE's QA/QC review, as well as contract compliance review comments of the plans shall be included in the QC appendix of the final plans.

3.3 (Task 3) Preparation and Submission of Plan of Operations **(Include IDW verbiage)**

The Contractor shall provide a Plan of Operations (which details specific information for the activities that are to be performed in the field). These plans shall be submitted and approved by USACE prior to start-up of construction field activities.

The Plan of Operations shall include at a minimum the following topics: Introduction (background, history and overview of remedy), Project Organization, Implementation of Selected Alternative (scheduling, site health and safety controls, access roads and

entrance gate, clearing and grubbing, erosion and sediment control, surface water controls, loading and off-site transportation of debris (if necessary)), borrow material, final site activities (seeding, establishing vegetation), Execution of Remedial Action (SSHP, QCP, contract administration, construction oversite and Project Oversite (scheduling, reporting requirements and SOW adjustments), list of applicable state and local laws and regulations, spill control/prevention (including names and telephone numbers of all personnel and offices to be contacted in the event of a spill that discharges into storm or sanitary sewer, streams or is over the reportable quantity), recycling and waste minimization, contaminant prevention, environmental monitoring, tree protection, soil disposal areas, disposal of solid wastes, clearing debris, disposal of contractor generated hazardous wastes, fuels and lubricants, historical, archeological and cultural resources (known or discovered), protection of water resources, protection of fish and wildlife resources, protection of air resources (particulates and other air pollutants), Inspection and Training of Contractor Personnel. This plan shall also include the Erosion Control Plan, the Spill Containment Plan, the Environmental Protection Plan and the Materials Handling Plan. These plans shall include, but not be limited to, sections that describe excavation methods, best management practices for managing excavated wastes, spoils, and runon/runoff, as well as showing the proposed limits of excavation. The plans shall be combined into the Plan of Operations so that there is only one document to keep track of at the project site. Many of the topics outlined above fall under the various plans required for the Plan of Operations. To keep the size of the document to a minimum, duplication of information throughout the plans should be avoided (if possible).

The Contractor shall also include in the Plan of Operations a Sampling and Analysis Plan that will outline the sampling and analysis required for disposal of the contaminated soil as well as that required for confirmation once excavation has been completed.

For all borrow sites (whether onsite or off-site), the Contractor shall sample the borrow material to ensure that it is not contaminated. Sampling shall be for VOCs (Method 8260A), SVOCs (Methods3540C/8270), TAL Metals (3050B/6010B/7471A) and PCBs (8082/3540B). These were the same sampling parameters used in the Remedial Investigation. The sampling and analysis shall be done in accordance with current USEPA SW-846 protocol.

The Contractor shall collect the potentially hazardous waste from the HTRW investigations, used PPE, decontamination liquids, and all waste generated from investigation activities. This media shall be containerized in sealable drums and placed in a secured area on the site until the results of the soil analyses are known. All drums shall be labeled as to project name, contents, boring number and date of collection, and secured to prevent public access. The drums shall be secured with tarps, ropes and pallets. Waste from different sites shall not be mixed.

The Contractor shall also include in the Plan of Operations an Investigative Derived Waste Plan (IDWP) for this project. The IDW Plan shall contain, at a minimum: analytical methods; management and containerization methods; and proposed disposal facilities. The IDW Plan shall address IDW generated on the sites. Actual disposal of IDW shall not occur until the test results are known and the IDW Plan has been approved

by USACE. If analyses of the samples taken from the sites indicate that regulated concentrations of hazardous contaminants are present, then the Contractor shall test the IDW material. If analyses of the IDW material indicate that regulated concentrations of hazardous contaminants are present, then the Contractor shall dispose of the IDW material collected from the sampling activities in accordance with local, state and federal regulations as outlined in the IDW Plan.

The Contractor shall immediately provide the lab analyses along with a letter stating which contaminants were found if the material has been designated as contaminated. The Contractor shall send this letter with results to the USACE Technical POC. The letter shall be included in the final IDW Plan. Once received, the Contractor shall use this information to properly dispose of the drums according to applicable state, federal and local regulations. The Contractor shall be responsible for laboratory analyses and proper disposal of IDW. Actual disposal of the IDW shall not occur until the test results are known. If the material is determined not to be a regulated waste, the Contractor shall dispose of the material in accordance with the IDW Plan, at no additional cost to the Government.

Quality Assurance reviews shall be conducted by the USACE on the IDW Plan. The final IDW Plan shall include, as an appendix, all USACE review comments and Contractor's responses, Independent Quality Control Team (IQCT) comments/responses, activity checklists and signed signature sheets.

3.4 (Task 4) Field Activities/Utilities

3.4.1 Field Activities. The site is currently owned by NASA Plum Brook Station (PBS), however, rights of entry are not required for this removal action. Coordination with PBS personnel will be conducted by USACE to ensure that the Contractor is allowed access to/from the site to perform all activities during this removal action. The Contractor shall be required to enter/exit through the PBS security gate, therefore, he shall follow all rules set forth by PBS security. The USACE shall be notified in writing at least two (2) weeks prior to commencement of any field work. The Contractor shall coordinate his field activities with all appropriate authorities and agencies as required. No field work shall be started until the QCP, SSHP and Plan of Operations have been approved by USACE. The Contractor shall prepare and submit to USACE a written response to all comments. The Contractor shall also be responsible for providing (with the notification) an up-to-date, detailed time schedule for the field work to be performed.

3.4.2 Utilities. As discussed in Section 1.1, there is the potential for active utilities to be encountered in several of the locations within TNT Area B.

> "Two NASA facilities are present at the site and are currently active for research purposes, the Hypersonic Tunnel Facility (HTF) and Nitrogen Dewar Tanks. The HTF is located in the northwest portion of TNTB and consists of a single building, above and below ground piping and utilities, and paved parking areas. The Nitrogen Dewar Tanks are located in the center of TNTB with aboveground piping and

underground utilities leading to the northwest, toward HTF, and to the northeast, offsite."

Because this land is currently owned and operated by NASA, the Contractor will have to coordinate their activities with NASA prior to commencing field activities and obtain a "digging permit" that will address all active and non-active lines in the project area. NASA POC for this action is Robert (Bob) Lallier, 419-621-3234, Robert.F.Lallier@grc.nasa.gov.

3.5 (Task 5) Site Survey

The Remedial Design and Feasibility Study documents include the survey data for sampling points within each of the contaminated areas within the TNT Area B site. This information will also be furnished to the Contractor on CD. The Contractor shall use this information to locate each contaminated area. Also, the Contractor shall be responsible for all surveying necessary for identifying limits of excavation once clean-up levels have been reached during excavation efforts.

3.6 (Task 6) Excavation of Contaminated Material.

The Contractor shall excavate approximately 3,300 cubic yards of contaminated material from the vicinity of the former TNT Area B site. The following paragraphs detail the different locations within the TNT Area B. Contaminants, levels of cleanup and excavation limits have already been identified during the Remedial Design and Feasibility Study phase of this project. All findings and recommendations have been verified and approved by Ohio EPA and are therefore to be used during this remedial construction effort. This material shall be excavated in a safe manner and activities shall adhere to all environmental and safety laws, regulations and ordinances. Any water generated during the excavation shall be containerized, sampled and disposed of in accordance with local, state and federal regulations. Before excavation shall begin the Contractor shall submit a plan (within the Plan of Operations) showing the proposed limits of excavation as they are given within the Feasibility Study.

3.6.1 Building 412 Sweating and Graining House. Total Remediation Volume is estimated at 266 Cubic Yards. The area is broken out into 3 smaller areas for excavation purposes. See Figure 1-4 from the Feasibility Study document.

Area A. The Contractor shall excavate approximately 222 cubic yards of material from this area. Dimensions are 50'x 20' x 6'. Primary contaminants are nitroaromatics and lead.

Area B. The Contractor shall excavate approximately 22 cubic yards of material from this area. Dimensions are 10' x 10' x 6'. Primary contaminants are nitroaromatics and lead.

Area C. The Contractor shall excavate approximately 22 cubic yards of material from this area. Dimensions are 10' x 10' x 6'. Primary contaminants are nitroaromatics and lead.

3.6.2 Building 417 Wastewater Settling Tanks. Total Remediation volume is estimated at 300 Cubic yards. The area is broken out into 4 smaller areas for excavation purposes. See Figure 1-6 from the feasibility Study document.

Area A. The Contractor shall excavate approximately 28 cubic yards of material from this area. Dimensions are 20'x 25' x 1.5'. Primary contaminants are nitroaromatics.

Area B. The Contractor shall excavate approximately 28 cubic yards of material from this area. Dimensions are 20'x 25' x 1.5'. Primary contaminants are nitroaromatics.

Area C. The Contractor shall excavate approximately 63 cubic yards of material from this area. Dimensions are 45' x 25' x 1.5'. Primary contaminants are nitroaromatics.

Area D. The Contractor shall excavate approximately 181 cubic yards of material from this area. Dimensions are 65'x 25' x 1.5'. Primary contaminants are nitroaromatics.

3.6.3 Building 452 Bi-Tri House. Total Remediation volume is estimated at 500 Cubic yards. The area is broken out into 2 smaller areas for excavation purposes. See Figure 1-10 from the Feasibility Study document.

Area A. The Contractor shall excavate approximately 417 cubic yards of material from this area. Dimensions are 25'x 45' x 10'. Primary contaminants are nitroaromatics and lead.

Area B. The Contractor shall excavate approximately 83 cubic yards of material from this area. Dimensions are 15'x 15' x 10'. Primary contaminants are nitroaromatics and lead.

3.6.4 Building 453 Fortifier House. The Contractor shall excavate approximately 71 cubic yards of material from this area. Dimensions are 15' x 15' x 10. Primary contaminants are nitroaromatics. See Figure 1-11 from the Feasibility Study document.

3.6.5 Building 456 Wash House. Total Remediation volume is estimated at 161 Cubic yards. The area is broken out into 7 smaller areas for excavation purposes. See Figure 1-12 from the feasibility Study document.

Area A. The Contractor shall excavate approximately 29 cubic yards of material from this area. Dimensions are 14'x 14' x 4'. Primary contaminants are nitroaromatics.

Area B. The Contractor shall excavate approximately 85 cubic yards of material from this area. Dimensions are 24'x 24' x 4'. Primary contaminants are nitroaromatics and lead.

Area C. The Contractor shall excavate approximately 52 cubic yards of material from this area. Dimensions are 27' x 13' x 4'. Primary contaminants are nitroaromatics.

Area D. The Contractor shall excavate approximately 30 cubic yards of material from this area. Dimensions are 20'x 10' x 4'. Primary contaminants are nitroaromatics.

Area E. The Contractor shall excavate approximately 15 cubic yards of material from this area. Dimensions are 10'x 10' x 4'. Primary contaminants are nitroaromatics.

Area F. The Contractor shall excavate approximately 15 cubic yards of material from this area. Dimensions are 10'x 10' x 4'. Primary contaminants are nitroaromatics.

Area G. The Contractor shall excavate approximately 15 cubic yards of material from this area. Dimensions are 10'x 10' x 4'. Primary contaminants are nitroaromatics.

3.6.6 Northeast Nail House. The Contractor shall excavate approximately 33 cubic yards of material from this area. Dimensions are 15' x 15' x 4'. Primary contaminants are nitroaromatics and lead. See Figure 1-13 from the Feasibility Study document.

3.6.7 Building 462 Bi-Tri House. The Contractor shall excavate approximately 67 cubic yards of material from this area. Dimensions are 15' x 15' x 8'. Primary contaminants are nitroaromatics. See Figure 1-16 from the Feasibility Study document.

3.6.8 Building 463 Fortifier House. The Contractor shall excavate approximately 296 cubic yards of material from this area. Dimensions are 40' x 20' x 10'. Primary contaminants are nitroaromatics and lead. See Figure 1-17 from the Feasibility Study document.

3.6.9 Building 466 Wash House. Total Remediation volume is estimated at 753 Cubic yards. The area is broken out into 4 smaller areas for excavation purposes. See Figure 1-18 from the feasibility Study document.

Area A. The Contractor shall excavate approximately 194 cubic yards of material from this area. Dimensions are 35'x 20' x 7.5'. Primary contaminants are nitroaromatics.

Area B. The Contractor shall excavate approximately 378 cubic yards of material from this area. Dimensions are 45'x 30' x 7.5'. Primary contaminants are nitroaromatics.

Area C. The Contractor shall excavate approximately 167 cubic yards of material from this area. Dimensions are 50' x 20' x 4.5'. Primary contaminants are nitroaromatics.

Area D. The Contractor shall excavate approximately 17 cubic yards of material from this area. Dimensions are 10'x 10' x 4.5'. Primary contaminants are nitroaromatics.

3.6.10 Northwest Nail House. The Contractor shall excavate approximately 78 cubic yards of material from this area. Dimensions are 20' x 30' x 3.5'. Primary contaminants are nitroaromatics. See Figure 1-19 from the Feasibility Study document.

3.6.11 Building 472 Bi-Tri House. Total Remediation volume is estimated at 190 Cubic yards. The area is broken out into 2 smaller areas for excavation purposes. See Figure 1-22 from the Feasibility Study document.

Area A. The Contractor shall excavate approximately 42 cubic yards of material from this area. Dimensions are 15'x 15' x 5'. Primary contaminants are nitroaromatics.

Area B. The Contractor shall excavate approximately 148 cubic yards of material from this area. Dimensions are 20'x 40' x 5'. Primary contaminants are nitroaromatics.

3.6.12 Building 473 Fortifier House. The Contractor shall excavate approximately 83 cubic yards of material from this area. Dimensions are 15' x 15' x 10'. Primary contaminants are nitroaromatics. See Figure 1-23 from the Feasibility Study document.

3.6.13 Building 476 Wash House. Total Remediation volume is estimated at 83 Cubic yards. The area is broken out into 2 smaller areas for excavation purposes. See Figure 1-24 from the Feasibility Study document.

Area A. The Contractor shall excavate approximately 58 cubic yards of material from this area. Dimensions are 35'x 15' x 3'. Primary contaminants are nitroaromatics.

Area B. The Contractor shall excavate approximately 25 cubic yards of material from this area. Dimensions are 15'x 15' x 3'. Primary contaminants are nitroaromatics.

3.7 (Task 7) Stabilization

Chemical stabilization will be required to treat the excavated soil classified as hazardous waste. An on-site mix box would be used to mix stabilizing agents with the contaminated soil. Representative samples of the stabilized soil would be taken for every 150 tons of processed soil. The samples would be tested for hazardous characteristics using the TCLP test. If the soil tests non-hazardous, it will be disposed in a non-hazardous waste landfill. If the soil tests hazardous, further stabilization would be needed or an alternative treatment would be required.

Since stabilization only alters the physical availability of the contaminants, using stabilized material as backfill at the site is prohibited. Therefore, clean fill material will be placed in the excavation pits, rough graded as necessary to achieve proper drainage, and reseeded.

3.8 (Task 8) Disposal/Investigative Derived Waste (IDW)

The Contractor shall arrange for sampling and analysis, transportation and disposal of material excavated from these areas. This alternative requires stabilization of the contaminated material prior to disposal, therefore, for estimating purposes, it is assumed that the material shall be placed in a non-hazardous waste landfill. The Contractor shall perform TCLP for Nitroaromatics as well as Metals (Lead) where required.

The Contractor shall collect the potentially hazardous waste, any used PPE, decontamination liquids, and all waste generated from the construction activities. This media shall be containerized and placed in a secured area on the site until the results of the analyses are known. All containers shall be labeled as to project name, contents, and date of collection, and secured to prevent tampering. If drums are used, they shall be secured with tarps, ropes and pallets. Waste from different sites shall not be mixed. Actual disposal of IDW shall not occur until the test results are known and the IDW Plan has been approved by USACE. If analyses of the samples taken from the sites indicate that regulated concentrations of hazardous contaminants are present, then the Contractor shall test the IDW material. If analyses of the IDW material indicate that regulated concentrations of hazardous contaminants are present, then the Contractor shall dispose of the IDW material collected from the sampling activities in accordance with local, state and federal regulations as outlined in the IDW Plan.

The Contractor shall immediately provide the lab analyses along with a letter stating which contaminants were found if the material has been designated as contaminated. The Contractor shall send this letter with results to the USACE. The letter shall be included in the final IDW Plan. Once received, the Contractor shall use this information to properly dispose of the drums according to applicable state, federal and local regulations. The Contractor shall be responsible for laboratory analyses and proper disposal of IDW. If the material is determined not to be a regulated waste, the Contractor shall dispose of the material in accordance with the IDW Plan.

3.9 (Task 9) Confirmation Sampling

The Contractor shall excavate to the horizontal and vertical limits outlined for each of the areas in the Feasibility Study. Once these limits have been reached, the Contractor shall use field screening, along with sampling efforts to determine if excavation of the contaminated soil (within the cleanup levels specified) have been reached. Once this determination has been made, the Contractor shall collect at a minimum, five samples from each individual excavation pit for confirmation analysis using SW 846 Method 8330 for nitroaromatics and Method 3050B/6010B/7471A for Metals (if required). The levels of PCBs found were below the regulatory limit of 50ppm (highest level found was

15 ppm) and should therefore not be a concern during confirmation and disposal. These samples shall be collected, preserved and shipped by the Contractor in accordance with the procedure discussed in the Sampling and Analysis Plans as well as the Plan of Operations. One shall be taken from each of the sidewalls near the midpoint of the excavation and at the floor near the midpoint of the excavation. For those areas where the length exceeds 20', 2 samples shall be taken along the length (whether this is on a side wall or on the floor). The contractor may use the individual site descriptions outlined in Task 3.6 to estimate the number of confirmatory samples needed. Also, depending on the landfill used, requirements for disposal may include additional testing (i.e., ignitabiligy, reactivity, corrosivity). If the remaining soil is determined to still be contaminated, the Contractor shall contact USACE to outline the additional excavation proposed.

3.10 (Task 10) Preparation and Submission of Draft and Final Remedial Action Report

The Contractor shall prepare a Remedial Action Summary Report, which details the field efforts in all areas. This report shall include at a minimum the following: Introduction, Site Location and description, History, Regulatory History, Background Soils information, Construction Activities (site prep, excavation, stabilization disposal, erosion control, backfilling, grading and seeding, basically detail where the material was removed from; manifest detailing where the material was sent for disposal; and analytical results from confirmation sampling), Performance Standards and Construction QC (Cleanup standards, SAP, etc), Final Inspection checklists. For estimating and preparation efforts, an example of this type of report shall be supplied to the Contractor. The Contractor is only expected to address those items that pertain to this project. Once the draft report has been generated, The Contractor shall submit it to USACE for review. Any comments arising from this review shall be incorporated by the Contractor into the final report. See Section 3.2 for QC review and documentation requirements. See Section 4.3 for reporting requirements.

3.11 (Task 11) Public Meeting Support

The AE shall support USACE project manager during public meetings necessary to discuss the work defined by this delivery order. It is assumed a maximum of 2 public meetings will be held to discuss the proposed work. The Contractor shall be responsible for preparing slides, handouts, and coordinating this public meeting. The Contractor shall place a notice in the local newspaper announcing the meeting and inviting the public to attend. The Contractor shall document the meeting minutes and supply these to the USACE project manager. If necessary the Contractor shall plan to give a presentation highlighting the requirements of this work.

4.0 Contractor Submittals / Schedule / Reporting / Other

4.1 Contractor Submittals

The Contractor shall furnish originals and copies of the work plans and response to comments in the quantities below. A written response to all comments shall also be prepared by the Contractor and included in the final submittal document. Submittals are as follows:

Draft and Final QCP, SSHP and Plan of Operations – 10 draft and 6 final copies of each plan to USACE

Draft and Final Remedial Action Summary Report – 10 draft and final copies to USACE

Addresses for submittals:

U.S. Army Corps of Engineers
Huntington District
502 Eighth Street
Huntington, WV 25701-2070
ATTN: CELRH-EC-CE (Lisa A. Humphreys)

4.2 Due Dates, Contractor Submittals and Action Items

Contractor Submittals / Action Items	No. Days
Notice to Proceed	0
Submission of Draft QCP, SSHP and Plan of Operations	20 Days after NTP on Construction Activities
Submission of Final QCP, SSHP and Plan of Operations	30 Days
Submission of Draft Remedial Action Summary Report	120 days
Submission of Final Remedial Action Summary Report	150 days

4.3 Reports

All work plans presenting data, analyses, recommendations, and drawings shall be prepared in a standard format for reports, as described herein. The Contractor shall submit copies of the draft and final versions of the work plans using MS Word. A CD ROM containing the text and drawings will be submitted along with the final work plan. A decimal paragraphing system shall be used. All site drawings shall be done in English units and of engineering quality with sufficient detail to show interrelations of major features on the site map (i.e. north arrows, keys, scales, etc.). When drawings are required, data may be combined to reduce the number of drawings, however, the drawings are not to be congested to the point that sight of the detail is lost. All drawings included in the reports shall be done on

Microstation 95 or newest version, conform to the current USACE CADD Standards and shall be submitted to USACE along with the final work plan. The report shall consist of 8.5" by 11" pages with drawings folded, if necessary, to this size. If the Contractor must submit large drawings (42" by 29" size) folded to 8.5" by 11", use of top loading sheet protectors for the folded drawings will be required. The Draft and Final Work Plans shall be bound in three-ring binders and clearly labeled as "Draft" and "Final", respectively. Appendices in the work plans will be identified by tabs or other approved manner. A title page shall identify the title, the Contractor, the Corps of Engineer, Huntington District, and the date. Plastic photo holder sheets are to be used when including photos in report. All photos are to be at least 35mm or digital color photos and properly labeled and put on a CD for storage. Plastic loose-leaf media files are to be used when submitting CD ROMS. Photo documentation for each of the individual sites shall be taken before and after construction activities.

4.4 Other

The Contractor shall maintain a file documenting all correspondence, phone conversations, and meetings with the USACE and other elements. It shall be bound in an appropriate folder and filed in reverse chronological order. This correspondence file shall be available for inspection at any time by the USACE upon request and shall be submitted to the USACE upon the conclusion of this work order.

Additional responsibilities of the Contractor under this work order include, but are not limited to, the following items of work:

1) The use of water will be required to control dust during construction activities. The amount of dust resulting from the construction activities shall be controlled to prevent the spread of dust to occupied areas near the construction site and to avoid creation of a nuisance in the surrounding area. Use of water shall not be allowed to result in, or create, hazardous or objectionable conditions such as flooding and pollution.
2) The Contractor is responsible for ensuring traffic safety in all work areas. Flagmen, temporary signage or other approved means shall be provided by the Contractor as needed to comply with the above requirement.
3) The use of burning at the project site for disposal of refuse and debris will not be permitted.
4) The Contractor shall have the following items on-site and available at any time: 1) SSHP, 2) QCP and 3) Plan of Operation.
5) The Contractor shall obtain all permits, licenses, and maintain these documents at the project site where work is to be performed and have such documents readily available. The Contractor shall insure that he meets all Federal, State and Local requirements for the safe removal, containment, hauling and disposal of materials related to the project activities.
6) Compliance with the provisions of this SOW by subcontractors will be the responsibility of the Contractor.

5.0 Payment

Construction work shall be negotiated as a lump sum to be billable periodically in accordance with the payments clause. This will include provision of documentation prior to payment as well as inspection of site for verification of activities performed. Upon construction completion, if it is determined that certain activities have not been performed or constructed, then costs for those shall not be billed by the Contractor.

6.0 Public Affairs

The Contractor shall not make available to the news media or publicly disclose any data generated or reviewed under this contract. When approached by the news media, the Contractor shall refer them to the USACE Contracting Officer (CO) for response. Reports and data generated under this contract shall become the property of the Government and distribution to any other source by the Contractor, unless authorized by the CO is prohibited.

7.0 Point of Contact

The Contractor shall supply USACE a point-of-contact to facilitate communications. USACE's point-of-contact for the work is:

USACE, Huntington District
502 8th Street
Huntington, WV 25701-2070
Attn: CELRH-EC-CE, Lisa Humphreys
(304) 529-5953

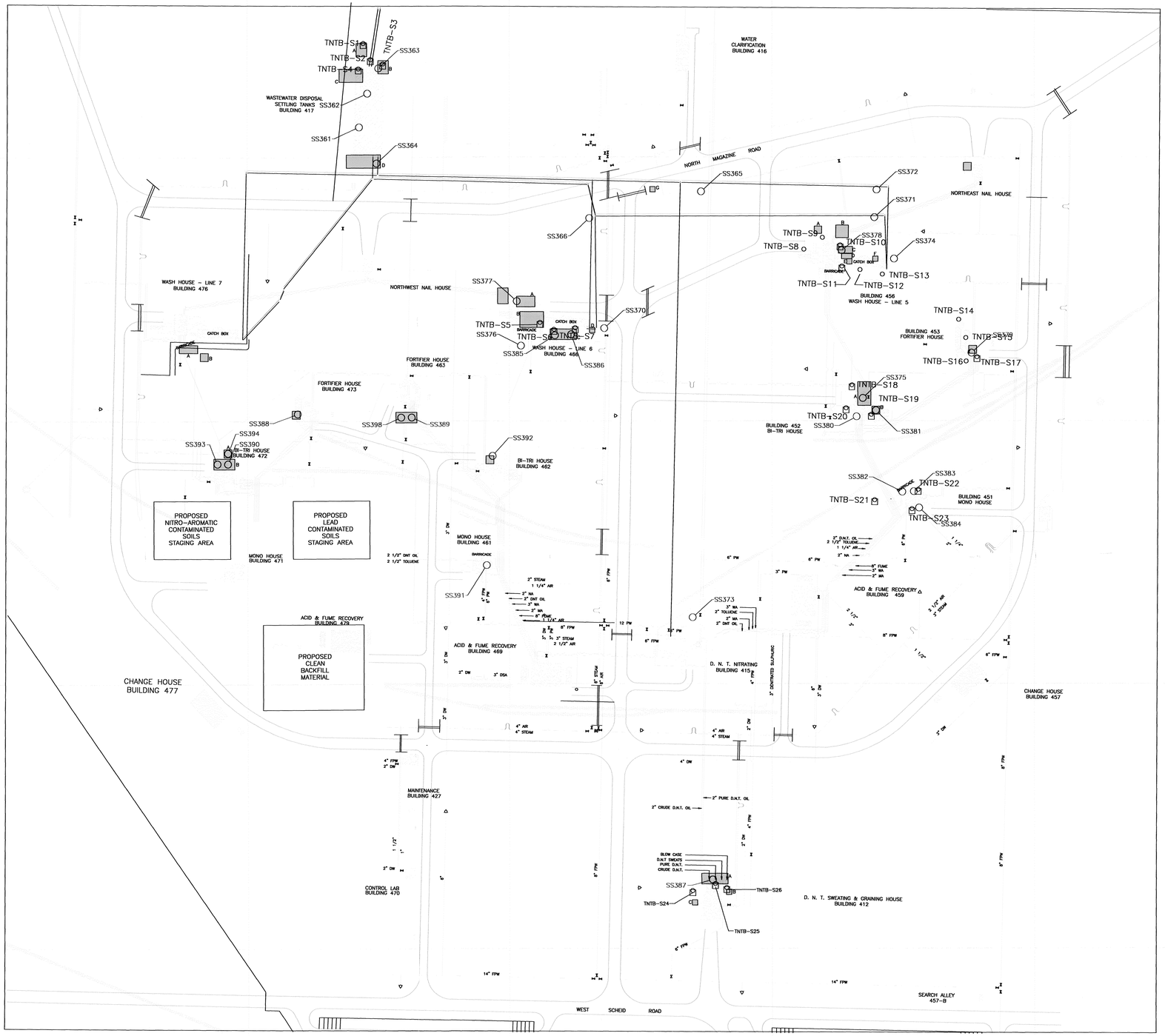
8.0 Reference Documents

8.1 TNT Area B Remedial Investigation, Former Plum Brook Ordnance Works, Sandusky, Ohio, Volume I – Final Report of Findings, IT Corporations, USACE, August 2000.

8.2 TNT Area B Remedial Investigation, Former Plum Brook Ordnance Works, Sandusky, Ohio, Volume IV – Final Feasibility Study, IT Corporations, USACE, July 2001.

8.3 Draft TNT Area B Action Memorandum, Former Plum Brook Ordnance Works, Sandusky, Ohio, USACE, March 2002.

Appendix B Site Map



LEGEND:

PROPOSED EXCAVATION SITES

PROPOSED CONTAMINATEDSOILS STAGING AREAS

100 0 100

SCALE: 1"=100'

US ARMY CORPS OF ENGINEERS

HUNTINGTON DISTRICT

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
TNT AREA B GENERAL SITE FEATURES MAP

PROPOSED STABILIZATION, EXCAVATION AND DISPOSAL OF CONTAMINATED SOIL

PREPARED BY:

Mountain State Company

P.O. BOX 0 • CEDAR GROVE, WV 25039
2318 E. DUPONT AVE. • BELLE, WEST VIRGINIA
PHONE (304) 949-4762 FAX (304) 949-4764

LOCATION

DATE PREPARED: JULY 2002

Appendix C Field Activity Forms

CONTRACTOR'S QUALITY CONTROL REPORT (QCR) (ER 1180-1-6)	DATE:	REPORT NO.

CONTRACT NUMBER AND NAME OF CONTRACTOR	DESCRIPTION AND LOCATION OF THE WORK: Tracts:
WasteTron ***Poca, WV***	***SEE BOTTOM OF PAGE***

WEATHER CLASSIFICATION:	CLASSIFICATION:
CLASS A No interruptions of any kind from weather conditions occurring on this or previous shifts.	CLASS _____
CLASS B Weather occurred during this shift that caused a complete stoppage of all work. CLASS C Weather occurred during this shift that caused a partial stoppage of work.	TEMPERATURE:
CLASS D Weather overhead excellent or suitable during shift. Work completely stopped due to results of previous adverse weather.	MAX ___ MIN ___
CLASS E Weather overhead excellent or suitable during shift but work partially stopped due to previous adverse manner.	PRECIPITATION:
OTHER Explain.	INCHES _____

CONTRACTOR/SUBCONTRACTORS AND AREA OF RESPONSIBILITY FOR WORK PERFORMED TODAY: *(Attach list of items of equipment either idle or working as appropriate.)*

a. ***Pickup truck, trailer, riding lawn mower, weed eater, tractor with brush hog***
b.
c.
d.
e.
f.
g.

1. WORK PERFORMED TODAY: *(Indicate location and description of work performed. Refer to work performed by prime and /or subcontractors by letter in Table above.)*

Performed general lawn mowing

2. TYPE AND RESULTS OF INSPECTION: *(Indicate whether: P-Preparatory, I-Initial, or F-Follow-up and include satisfactory work completed or deficiencies with action to be taken.)*

N/A

3. TESTS REQUIRED BY PLANS AND/OR SPECIFICATIONS PERFORMED AND RESULTS OF TESTS:

N/A

4. VERBAL INSTRUCTIONS RECEIVED: (*List any instructions given by Government personnel on construction deficiencies, retesting required, etc., with action to be taken.*)

NONE

5. REMARKS: *(Cover any conflicts in plans, specifications or instructions: acceptability of incoming materials; offsite surveillance activities; progress of work, delays, causes and extent thereof; days of no work with reasons for same.)*

N/A

6. SAFETY: *(Include any infractions of approved safety plan, safety manual or instructions from Government personnel. Specify corrective actions taken.)*

ALL SAFETY EQUIPMENT WORN

INSPECTOR

CONTRACTOR'S CERTIFICATION: I certify that the above report is complete and correct and that all material and equipment used, work performed and tests conducted during this reporting period were in strict compliance with the contract plans and specifications except as noted above.

CONTRACTOR'S APPROVED AUTHORIZED REPRESENTATIVE

(For Safety Staff only)	REPORT NO.	EROC CODE	UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT (For Use of this Form See Help Menu and USACE Suppl to AR 385-40)	REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2)

1. ACCIDENT CLASSIFICATION

PERSONNEL CLASSIFICATION	INJURY/ILLNESS/FATAL	PROPERTY DAMAGE	MOTOR VEHICLE INVOLVED	DIVING
GOVERNMENT ☐ CIVILIAN ☐ MILITARY	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ CONTRACTOR	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ PUBLIC	☐ FATAL ☐ OTHER		☐	

2. PERSONAL DATA

a. Name (Last, First, MI)	b. AGE	c. SEX ☐ MALE ☐ FEMALE	d. SOCIAL SECURITY NUMBER	e. GRADE

f. JOB SERIES/TITLE	g. DUTY STATUS AT TIME OF ACCIDENT	h. EMPLOYMENT STATUS AT TIME OF ACCIDENT
	☐ ON DUTY ☐ TDY ☐ OFF DUTY	☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER ☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL ☐ TEMPORARY ☐ INVOLUNTARY ☐ OTHER (Specify)

3. GENERAL INFORMATION

a. DATE OF ACCIDENT (month/day/year)	b. TIME OF ACCIDENT (Military time) hrs	c. EXACT LOCATION OF ACCIDENT	d. CONTRACTOR'S NAME (1) PRIME: (2) SUBCONTRACTOR:

e. CONTRACT NUMBER	f. TYPE OF CONTRACT	g. HAZARDOUS/TOXIC WASTE ACTIVITY
☐ CIVIL WORKS ☐ MILITARY ☐ OTHER (Specify)	☐ CONSTRUCTION ☐ SERVICE ☐ A/E ☐ DREDGE ☐ OTHER (Specify)	☐ SUPERFUND ☐ DERP ☐ IRP ☐ OTHER (Specify)

4. CONSTRUCTION ACTIVITIES ONLY *(Fill in line and corresponding code number in box from list - see help menu)*

a. CONSTRUCTION ACTIVITY	(CODE) #	b. TYPE OF CONSTRUCTION EQUIPMENT	(CODE) #

5. INJURY/ILLNESS INFORMATION *(Include name on line and corresponding code number in box for items e, f & g - see help menu)*

a. SEVERITY OF ILLNESS/INJURY	(CODE) #	B. ESTIMATED DAYS LOST	C. ESTIMATED DAYS HOSPITALIZED	D. ESTIMATED DAYS RESTRICTED DUTY

c. BODY PART AFFECTED	(CODE)	g. TYPE AND SOURCE OF INJURY/ILLNESS	(CODE)
PRIMARY	#	TYPE	#
SECONDARY	#	SOURCE	#
e. NATURE OF ILLNESS / INJURY	#		

6. PUBLIC FATALITY *(Fill in line and correspondence code number in box - see help menu)*

a. ACTIVITY AT TIME OF ACCIDENT	(CODE) #	b. PERSONAL FLOATATION DEVICE USED? ☐ YES ☐ NO ☐ N/A

7. MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE	b. TYPE OF COLLISION	c. SEAT BELTS	USED	NOT USED	NOT AVAILABLE
☐ PICKUP/VAN ☐ AUTOMOBILE ☐ TRUCK ☐ OTHER (Specify)	☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END ☐ BROADSIDE ☐ ROLL OVER ☐ BACKING ☐ OTHER (Specify)	(1) FRONT SEAT			
		(2) REAR SEAT			

8. PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM	B. OWNERSHIP	C. $ AMOUNT OF DAMAGE
(1)		
(2)		
(3)		

9. VESSEL/FLOATING PLANT ACCIDENT *(Fill in line and correspondence code number in box from list - see help menu)*

a. TYPE OF VESSEL/FLOATING PLANT	(CODE) #	b. TYPE OF COLLISION/MISHAP	(CODE) #

10. ACCIDENT DESCRIPTION *(Use additional paper, if necessary)*

See attached page.

11. CAUSAL FACTOR(S) *(Read Instruction Before Completing)*

a. (Explain YES answers in item 13)

	YES	NO
DESIGN: Was design of facility, workplace or equipment a factor?	☐	☐
INSPECTION/MAINTENANCE: Were inspection & maintenance procedures a factor?	☐	☐
PERSON'S PHYSICAL CONDITION: In your opinion, was the physical condition of the person a factor?	☐	☐
OPERATING PROCEDURES: Were operating procedures a factor?	☐	☐
JOB PRACTICES: Were any job safety/health practices not followed when the accident occurred?	☐	☐
HUMAN FACTORS: Did any human factors such as, size or strength of person, etc., contribute to accident?	☐	☐
ENVIRONMENTAL FACTORS: Did heat, cold, dust, sun, glare, etc., contribute to the accident?	☐	☐

a. *(CONTINUED)*

	YES	NO
CHEMICAL AND PHYSICAL AGENT FACTORS: Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents, such as, noise, radiation, etc., contribute to accident?	☐	☐
OFFICE FACTORS: Did office setting such as, lifting office furniture, carrying, stooping, etc., contribute to the accident?	☐	☐
SUPPORT FACTORS: Were inappropriate tools/resources provided to properly perform the activity/task?	☐	☐
PERSONAL PROTECTIVE EQUIPMENT: Did the improper selection, use or maintenance of personal protective equipment contribute to the accident?	☐	☐
DRUGS/ALCOHOL: In your opinion, was drugs or alcohol a factor to the accident	☐	☐

b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT?

☐ YES *(If yes, attach a copy.)* ☐ NO

12. TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?	b. TYPE OF TRAINING.	c. DATE OF MOST RECENT FORMAL TRAINING.
☐ YES ☐ NO	☐ CLASSROOM ☐ ON JOB	(Month) (Day) (Year)

13. FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES *(See instruction for definition of direct and indirect causes.) (Use additional paper, if necessary)*

a. DIRECT CAUSE

See attached page.

b. INDIRECT CAUSE(S)

See attached page.

14. ACTION(S) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S).

DESCRIBE FULLY:

See attached page.

15. DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.

a. BEGINNING (Month/Day/Year)	b. ANTICIPATED COMPLETION (Month/Day/Year)

c. SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT	d. DATE *(Mo/Da/Yr)*	e. ORGANIZATION IDENTIFIER *(Div, Br, Sect)*	f. OFFICE SYMBOL
CORPS _____ CONTRACTOR _____			

16. MANAGEMENT REVIEW *(1st)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

17. MANAGEMENT REVIEW *(2nd - Chief Operations, Construction, Engineering, etc.)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

18. SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW

a. ☐ CONCUR b. ☐ NON CONCUR c. ADDITIONAL ACTIONS/COMMENTS

SIGNATURE	TITLE	DATE

19. COMMAND APPROVAL

COMMENTS

COMMANDER SIGNATURE	DATE

*U.S. GOVERNMENT PRINTING OFFICE: 1993-0-791-757

10. ACCIDENT DESCRIPTION *(Continuation)*

13a. DIRECT CAUSE *(Continuation)*

13b.	INDIRECT CAUSES *(Continuation)*

14.	ACTION(S) TAKEN, ANTICIPATED, OR RECOMMENDED TO ELIMINATE CAUSE(S) *(Continuation)*

REIC

CHAIN OF CUSTODY RECORD NO. 62533

REI Consultants, Inc.
225 Industrial Park Rd.
P.O. Box 286, Beaver, WV 25813
Phone: 304-255-2500 or 800-999-0105
FAX: 304-255-2572

CLIENT: _____ CONTACT PERSON: _____

ADDRESS: _____ TELEPHONE/FAX: _____

CITY/STATE/ZIP: _____ SITE ID & STATE: _____

BILL TO: _____ PROJECT ID: _____

CITY/STATE/ZIP: _____ SAMPLER: _____

SAMPLE LOG AND ANALYSIS REQUEST

TURNAROUND TIME REQUIREMENTS
REGULAR: ___
*RUSH: ___ 5-Day
___ 3-Day
___ 2-Day
___ 1-Day
*Rush work needs prior Laboratory approval and will include surcharges

PRESERVATIVES
0 No Preservative
1 Hydrochloric Acid
2 Nitric Acid
3 Sulfuric Acid
4 Sodium Thiosulfate
5 Sodium Hydroxide
6 Zinc Acetate
7 EDTA

PRESERVATIVE CODES

NOTE PRESERVATIVES →

ANALYSIS REQUESTED & METHOD

SAMPLE ID	NO. & TYPE OF CONTAINERS	SAMPLING DATE / TIME	MATRIX	SAMPLE COMP / GRAB								COMMENTS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time

Special Requests:

Sample Condition: Good? Y N

Temperature Upon Arrival °C

Shipment: Hand-Del: Courier: UPS: FedEx:

Shipment Date: FAX Results: Y N

Appendix D Laboratory QA Plan

REIC's QA Plan

REIC

Research Environmental
& Industrial Consultants, Inc.

REI Consultants, Inc

Comprehensive Quality Assurance Plan

2001 - 2002

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Section 1.0

Statement of Policy

1.0 Policy Statement

1.1 Purpose: This is a comprehensive quality assurance plan (CompQAP) for Research, Environmental and Industrial Consultants, Inc. (REIC). This document describes REIC's quality assurance program as a consulting and analytical services laboratory. A well conceived QA program enables REIC to provide a sound framework for generation of field and laboratory data that is valid, comparable, representative and defensible. Specifically, these objectives are routinely achieved by:

- Estimating the quality of each analytical system, including precision, accuracy, and sensitivity sufficient for requirements of each project;
- Ensuring early identification of deficiencies which might affect quality of data of each project;
- Requiring a sufficient level of documentation to verify the quality of data generated for each project; and
- Validating and evaluating field information and analytical results to define data usability.

REIC emphasizes the application of sound quality assurance (QA) and quality control (QC) principles starting from the project initiation, through all laboratory activities and finally to the production of the final project analytical report. This document is designed to provide not only a uniform set of procedures, but also a means to measure the quality of data generated.

The validity and reliability of the information generated is assured and enhanced by the adherence to documented quality control procedures and quality assurance protocols.

1.2 Scope of the QA Program: Understanding the scope of the QA program requires discerning the differences between QC and QA. Quality control refers to specific actions (procedures) designed to ensure that system performance is consistent with established acceptance criteria (limits). It is these specific actions that will ensure data accuracy, precision, and comparability. When the system performance is consistent with the established limits, we say that the data has been generated under in-control conditions. When not consistent, data is considered generated under out-of-control system conditions.

Quality assurance refers to the system whereby an organization, such as REIC, provides assurance to its clients that monitoring of quality-related activities has occurred (or is occurring). Implementation of the QA program, described in this CompQAP, is designed to ensure that data generated by REIC is collected under in-control conditions and sufficient documentation is available to support the data.

1.3 APPLICATION: This Comprehensive QA Plan describes REIC's QA program as it applies to field and laboratory activities, which generate analytical chemical data. This includes field activities, which may affect chemical integrity of samples, as well as chemical laboratory activities. Air sampling, biological sampling, toxicological studies, geotechnical parameter measurements, while not directly addressed in this plan, are sufficiently supported by the general principles described herein. Specific

procedures and requirements are provided for sampling and analysis of:

- Domestic and industrial solid waste and wastewater sampling
- Soil and sediment sampling
- Nonpotable water
- Potable water
- Surface water sampling (ponds, streams, rivers)
- Monitoring wells sampling
- Air screening/monitoring
- Method development to support toxicological studies (acute and/or chronic effects).

Note: REIC is not responsible for field activities conducted by the client(s).

Analytical methodologies to which this CompQAP will support include:

- Gas chromatography
- Gas chromatography/Mass spectrometry
- Liquid chromatography
- Atomic absorption/emission
- Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP/AES)
- Inductively Coupled Plasma/Mass Spectroscopy (ICP/MS)
- Wet chemistry analysis
- Ion chromatography
- UV-VIS spectroscopy
- Combustion analysis for TOX and TOC
- Material characterization
- Hydrocarbon characterization
- Infrared characterization
- Aquatic Biology evaluations
- TCLP extractions and evaluations

1.4 DOCUMENT UPDATES: This CompQAP shall be reviewed and updated on a periodic basis as personnel and equipment are changed or added. Also, as new quality control procedures for field and laboratory work are developed and approved, they will be introduced to provide additional statistical information. Date and revision number will document all changes.

1.5 QUALITY ASSURANCE PROJECT PLANS: This CompQAP can be modified to a site specific Quality Assurance Project Plan. The site-specific requirements of a project as specified in the project scope of work (or work plan) are incorporated into the Quality Assurance Project Plan (QAPP). A typical project description will include the following information:

- Project background, site description, overall project objectives, intended use of acquired data and project schedule (this information will be presented in section 1.0 of the QAPP and will replace the information currently contained in section 1.0 of this CompQAP).
- List of measurement parameters, including the acceptance criteria (precision/ accuracy) of control analytes and the detection limits for the

full list of the project analytes (section 3.0 of this CompQAP will be modified).

- Tables for the number of samples to be collected and field QC samples, map of sampling locations, types of samples to be collected i.e. surface water, groundwater, soil, sediment, sludge (will be added into Section 4.0).

Section 2.0

Organization & Responsibilities

2.0 Organization and Responsibilities[1]

2.1 PROJECT DIRECTOR: REIC's Laboratory Director and/or Assistant Director are the project directors for all field and laboratory projects. The project director is responsible for all contractual obligations of the proposed work and direct corporate efforts as needed to achieve the project goals of schedule, cost, and technical performance. The project director's responsibilities include:

- Appointing the Project Manager for field project operations, the Assistant Laboratory Director (Inorganic and Organic) for laboratory operations, supervising these individuals in performance of project duties,
- Approving all field and laboratory QC procedures,
- Allocating manpower,
- Reviewing and approving new contracts and contract changes.

2.2. FIELD PROJECT OPERATIONS: The Project Manager is responsible for effective day-to-day management of the project staff as well as direct communication and liaison with the client and the Laboratory Directors. The Project Manager has the ultimate responsibility of ensuring that all project quality control (QC) procedures are followed by the field team in the performance of the project. The Project Manager may appoint the field team leader (sampling team project leader). The field team leader is responsible to the Project Manager for ensuring that all QC and technical field procedures are followed, and that all field activities are documented properly. The field team leader and field team members must bring any unusual observations or problems to the immediate attention of the Project Manager and/or the Project QA Officer.

2.3. LABORATORY OPERATIONS:

2.3.1 ANALYTICAL DIVISION MANAGEMENT

The Laboratory and Assistant Laboratory Directors are responsible for the overall management of the analytical division (i.e. Organics, Inorganics, Aquatic Biology, etc.), including the supervision of the

[1] REIC's organization, line of authority, and technical area breakdown is enclosed at the end of this section. The firm's president can be reached at: REI Consultants, Inc., PO Box 286 Beaver West Virginia 25813.

laboratory managers, project chemists, and analysts. For field studies, resulting in subsequent sample analyses, the Laboratory Managers are responsible to the Laboratory Directors for ensuring that all personnel under his/her direction are knowledgeable of the laboratory QA/QC requirements of the project. Other direct responsibilities include: analytical data final report generation and coordination with the project QA officer for ensuring that the data is validated prior to release to clients.

2.3.2 *LABORATORY MANAGER*

Laboratory Managers are under the direct supervision of the Laboratory and Assistant Laboratory Directors. The Laboratory Managers are responsible for providing consistent and accurate laboratory data produced by the analysts for compliance with precision, accuracy, and completeness objectives before final report generation. Other responsibilities include the review of final data reports and of any QC deficiencies reported by the analyst and/or project QA Officer.

2.3.3 *PROJECT CHEMISTS*

It is the responsibility of the Project Chemists to assist the Laboratory Managers in providing consistent and accurate laboratory data produced by the analysts for compliance with precision, accuracy, and completeness objectives before final report generation. This is includes assisting the Laboratory Managers in the review of final data reports and of any QC deficiencies reported by the analyst and/or project QA Officer.

2.3.4 *LABORATORY ANALYST*

It is the responsibility of the Analysts to perform instrument calibrations, calibration verifications, and preliminary QC checks to ensure that each batch of data being generated passes all required QC criteria. The Analyst is responsible for incorporating any data changes, resulting from the review by the project QA Officer and/or the Project Chemist, into the respective job file folder and LIMS.

2.3.5 *PROJECT MANAGER*

The Laboratory Director appoints the Project Manager. The Project Manager acts as a liaison between the field team and laboratory operations. The Project Manager is responsible for sample custody receipt from field members, sample integrity verification, and sample transfer to the appropriate

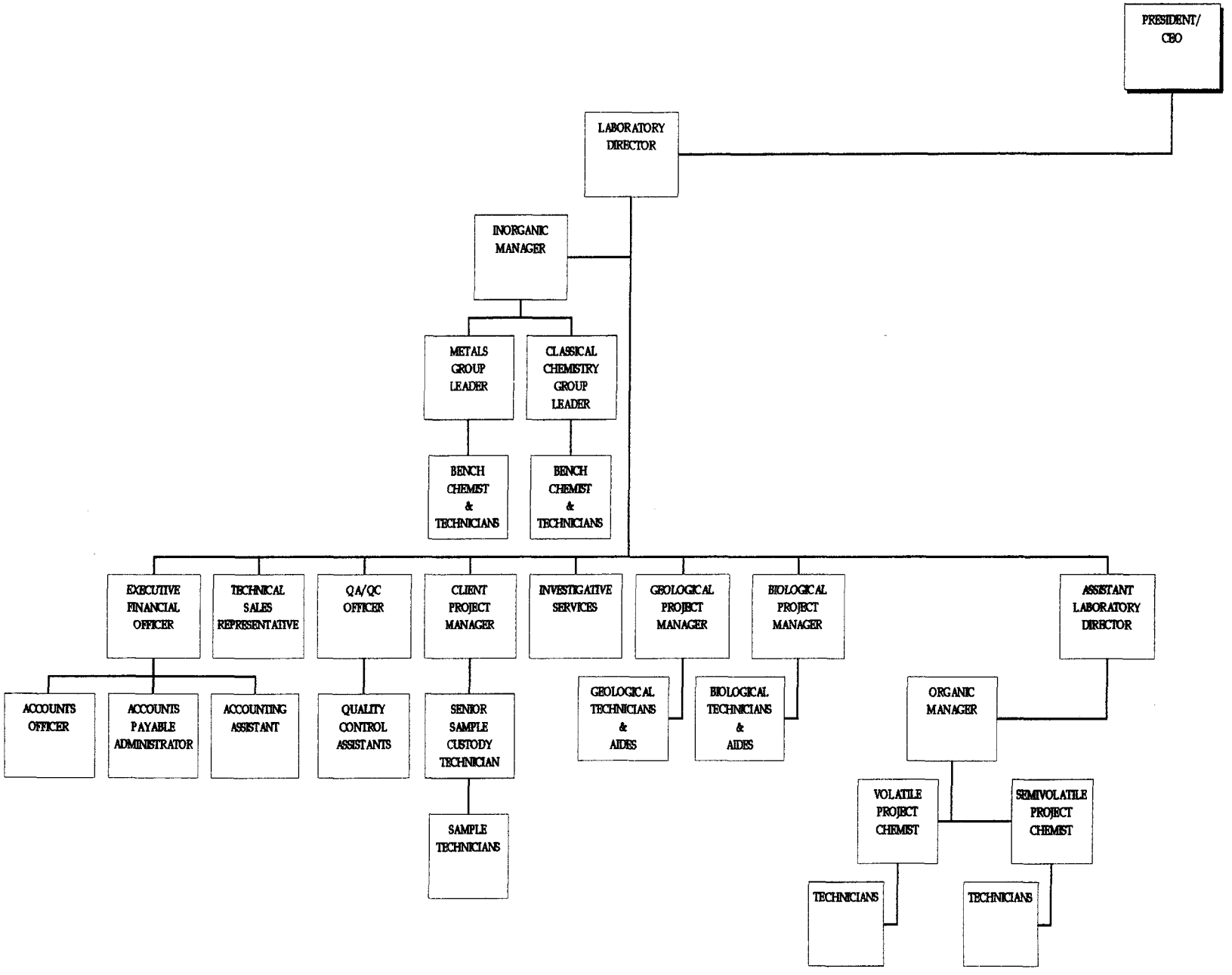
analytical divisions. Using LIMS, the laboratory's computer network, the Project Manager correlates sample preparation and analyses with the laboratory's head sample custodian to meet project objectives.

2.4 QUALITY ASSURANCE PROGRAM: REIC's Laboratory Director appoints the Project QA Officer and is responsible for supervising the QA Officer in the performance of his/her project duties. The QA Officer maintains the overall company QA program and interacts with the Project Managers, Assistant Laboratory Directors, Project Chemists, and client QA/QC personnel to correct problem situations as necessary. The REIC project QA officer has direct responsibility for assessing QC performance, determining if QA objectives are being met, recommending corrective actions, and keeping the Project Manager and the Laboratory Directors informed of all relevant QA/QC information. The Project QA Officer is independent of the project team and answers directly to the Laboratory Director. The Project QA Officer is specifically responsible for the following:

- Assessing that approved QA/QC procedures are being applied to a project;
- Conducting both performance and systems audits of laboratory and field operations to ensure compliance with the requirements of the company QA program (stated in SOPs, CompQAP and/or QAPP);
- Identifying any QC deficiencies on project activities and notifying the Project Manager or the Laboratory Directors of any QC deficiencies discovered during audits;
- Providing an independent review of field information and analytical data packages to ensure the quality of all deliverables from the project team to the client;
- Interacting and communicating with client QA officer to resolve QA/QC problems specific to a project;
- Reporting to the director on a monthly basis (or more frequent as needed) on the QA status of on-going projects and on a quarterly basis on the findings from formal audits;
- Monitoring the QA and QC activities of the laboratory to ensure conformance with approved company policies, procedures, sound practices, and recommend improvements as necessary;
- Ensure that sampling is conducted in a manner consistent with the CompQAP or QAPP;
- Periodically conduct field audits to inspect sampling activities; and

- **Periodically audit sampling documentation and procedures to ensure that samples are labeled, preserved, stored, and transported according to approved chain-of-custody procedures.**

ORGANIZATIONAL CHART



Section 3.0

Quality Assurance Objectives for Data Measurements

3.0 QA Objectives for Data Measurements

The overall quality assurance objective is to ensure that data of known and acceptable quality is generated. The quality of data is measured through qualitative and quantitative parameters. These parameters include accuracy, precision, completeness, representativeness, and comparability.

Proper execution of each project task is needed in order to yield consistent information, results that are representative of the media and conditions being measured, and ultimately be useful for meeting the intended project objectives. REIC laboratory will calculate and report data in units consistent with those of other organizations and agencies to allow comparability of databases.

REIC laboratory performs analyses for specified compounds using the standardized methods. In the process, baseline data is applied to establishing control limits for daily analyses. These control limits, which include precision, accuracy, and reporting limits, may therefore be considered for typical performance.

3.1 COMPARABILITY: Comparability is the confidence with which one data set can be compared with another. These data sets include data generated by different laboratories performed under the same work plan, data generated by laboratories in previous years, or data generated using differing techniques or analytical protocols. The comparability objectives of REIC are as follows:

1. Demonstrate traceability of standards to the National Institute of Standards and Technology (NIST) or EPA approved sources,
2. Use standard methodology,
3. Report results from similar matrices in standard units,
4. Apply appropriate levels of QC within the context of the laboratory QA program, and
5. Participate in interlaboratory studies to document laboratory performance.

When traceable standards and standard methodology are used, the analytical results can be compared to other similarly operating laboratories.

3.2 REPRESENTATIVENESS: Representativeness expresses the degree to which sample data accurately and precisely represents actual conditions. Representativeness is a qualitative determination. The representativeness objective of REIC's quality assurance program is to eliminate conditions that may result in non-representative data. In the laboratory proper temperature, extraction, and sample holding times are closely observed to ensure that sample integrity is maintained. Also, blank samples are examined for cross contamination.

3.3 COMPLETENESS: Completeness is a measure of the amount of the data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. The minimum level of completeness expected is 95 percent for each analytical method requested. This is expected to be achieved by ensuring proper sample extraction procedures. Also, for each sample received by the laboratory, especially those shipped in fragile containers, a backup sample is to be made available in case breakages occur, or when the analyses criteria are not initially met.

3.4 ACCURACY: Accuracy is the degree to which a measurement agrees with the actual value, i.e. amount of measurement bias. Accuracy is expressed as a percent recovery of a concentration of reference material (or laboratory standard). The accuracy of an analytical procedure is determined by addition of a known amount of spike standard to a field sample matrix or a laboratory control matrix. A control matrix is made of distilled (or deionized) water or sterile, clean soil (with known physical and chemical properties). The field sample matrix is described as all components of the sample mixture except the analyte (compound being measured).

A method for the determination of accuracy values, which is routinely used in the laboratory, is described in section 12.0 of this CompQAP. Examples of accuracy acceptance criteria for control analytes and associated method reporting limits are presented in **Tables 3-1** through **3-4**.

3.5 PRECISION: Precision is a measure of the degree of reproducibility of an analytical value and it is used as a check of the quality of the sampling and analytical procedures. Precision is determined by analyzing replicate samples. The significance of a precision measurement depends on whether the sample is a field duplicate, laboratory control matrix duplicate, or a matrix spike duplicate. Laboratory determination of precision is discussed in section 12.0 of this CompQAP. Examples of current precision

acceptance criteria for control analytes along with associated method reporting limits and method detection limits are presented in **Tables 3-1** through **3-4**.

TABLE 3-1A *Volatile Organic Compounds by Method 524.2*

	---Accuracy---		Precision	---MQL---		
Parameter	*Aqueous %R*	*Solid %R*	*Max RPD*	*Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
Benzene	*80 - 120*	*NA*	*20*	*1*	*NA*	*0.10*
Bromochloromethane	*80 - 120*	*NA*	*20*	*1*	*NA*	*0.15*
Bromodichloromethane	*80 - 120*	*NA*	*20*	*1*	*NA*	*0.13*
Bromoform	*80 - 120*	*NA*	*20*	*1*	*NA*	*0.18*
Bromomethane	*80 - 120*	*NA*	*20*	*1*	*NA*	*0.28*
n-Butylbenzene	80 - 120	NA	20	1	NA	0.21
sec-Butylbenzene	80 - 120	NA	20	1	NA	0.12
tert-Butylbenzene	80 - 120	NA	20	1	NA	0.11
Carbon tetrachloride	80 - 120	NA	20	1	NA	0.10
Chlorobenzene	80 - 120	NA	20	1	NA	0.08
Chloroethane	80 - 120	NA	20	1	NA	0.09
Chloroform	80 - 120	NA	20	1	NA	0.10
Chloromethane	80 - 120	NA	20	1	NA	0.15
2-Chlorotoluene	80 - 120	NA	20	1	NA	0.08
4-Chlorotoluene	80 - 120	NA	20	1	NA	0.07
Dibromochloromethane	80 - 120	NA	20	1	NA	0.16
1,2-Dibromo-3-Chloropropane	80 - 120	NA	20	1	NA	0.15
1,2-Dibromoethane	80 - 120	NA	20	1	NA	0.18
Dibromomethane	80 - 120	NA	20	1	NA	0.28
1,2-Dichlorobenzene	80 - 120	NA	20	1	NA	0.15
1,3-Dichlorobenzene	80 - 120	NA	20	1	NA	0.11
1,4-Dichlorobenzene	80 - 120	NA	20	1	NA	0.14
Dichlorodifluoromethane	80 - 120	NA	20	1	NA	0.10
1,1-Dichloroethane	80 - 120	NA	20	1	NA	0.08
1,2-Dichloroethane	80 - 120	NA	20	1	NA	0.15
1,1-Dichloroethene	80 - 120	NA	20	1	NA	0.10

TABLE 3-1A *Volatile Organic Compounds by Method 524.2*

	---Accuracy---		Precision	---MQL---		
Parameter	*Aqueous %R*	*Solid %R*	*Max RPD*	*Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
cis-1,2-Dichloroethene	80 - 120	NA	20	1	NA	0.29
trans-1,2-Dichloroethene	80 - 120	NA	20	1	NA	0.08
1,2-Dichloropropane	80 - 120	NA	20	1	NA	0.14
1,3-Dichloropropane	80 - 120	NA	20	1	NA	0.15
2,2-Dichloropropane	80 - 120	NA	20	1	NA	0.16
1,1-Dichloropropene	80 - 120	NA	20	1	NA	0.12
cis-1,3-Dichloropropene	80 - 120	NA	20	1	NA	0.13
trans-1,3-Dichloropropene	80 - 120	NA	20	1	NA	0.18
Ethylbenzene	80 - 120	NA	20	1	NA	0.07
Hexachlorobutadiene	80 - 120	NA	20	1	NA	0.10
Isopropylbenzene	80 - 120	NA	20	1	NA	0.10
4-Isopropyltoluene	80 - 120	NA	20	1	NA	0.13
Methylene chloride	80 - 120	NA	20	1	NA	0.10
Naphthalene	80 - 120	NA	20	1	NA	0.25
Styrene	80 - 120	NA	20	1	NA	0.16
1,1,1,2-Tetrachloroethane	80 - 120	NA	20	1	NA	0.10
Tetrachloroethene	80 - 120	NA	20	1	NA	0.08
Toluene	80 - 120	NA	20	1	NA	0.09
1,2,3-Trichlorobenzene	80 - 120	NA	20	1	NA	0.19
1,2,4-Trichlorobenzene	80 - 120	NA	20	1	NA	0.16
1,1,1-Trichloroethane	80 - 120	NA	20	1	NA	0.08
1,1,2-Trichloroethane	80 - 120	NA	20	1	NA	0.18
Trichloroethene	80 - 120	NA	20	1	NA	0.09
Trichlorofluoromethane	80 - 120	NA	20	1	NA	0.11
1,2,3-Trichloropropane	80 - 120	NA	20	1	NA	0.62
1,2,4-Trimethylbenzene	80 - 120	NA	20	1	NA	0.10

TABLE 3-1A *Volatile Organic Compounds by Method 524.2*

	---Accuracy---		Precision	---MQL---		
Parameter	*Aqueous %R*	*Solid %R*	*Max RPD*	*Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
1,3,5-Trimethylbenzene	80 - 120	NA	20	1	NA	0.10
Vinyl chloride	80 - 120	NA	20	1	NA	0.10
Xylenes	80 - 120	NA	20	1	NA	0.32
SURROGATES						
1,2-Dichloroethane-$_{d4}$	76 - 114	NA	20	NA	NA	NA
Toluene-$_{d8}$	88 - 110	NA	20	NA	NA	NA
4-Bromofluorobenzene	86 - 115	NA	20	NA	NA	NA

TABLE 3-1B Volatile Organic Compounds by Methods 601/8010B

Parameter	—Accuracy— Aqueous %R	Solid %R	Precision Max RPD	—MQL— Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
Bromodichloromethane	42 - 172	65 - 130	30	2	2	0.24
Bromoform	13 - 159	65 - 130	30	2	2	0.08
Bromomethane	D - 144	65 - 130	30	2	2	0.33
Carbon tetrachloride	43 - 143	65 - 130	30	2	2	0.16
Chlorobenzene	38 - 150	65 - 130	30	2	2	0.08
Chloroethane	46 - 137	65 - 130	30	2	2	0.13
Chloroform	49 - 133	65 - 130	30	2	2	0.34
Chloromethane	D - 193	65 - 130	30	2	2	0.20
Dibromochloromethane	24 - 191	65 - 130	30	2	2	0.12
1,2-Dichlorobenzene	D - 208	65 - 130	30	2	2	0.18
1,3-Dichlorobenzene	7 - 187	65 - 130	30	2	2	0.11
1,4-Dichlorobenzene	42 - 143	65 - 130	30	2	2	0.13
1,1-Dichloroethane	47 - 132	65 - 130	30	2	2	0.11
1,2-Dichloroethane	51 - 147	65 - 130	30	2	2	0.19
1,1-Dichloroethene	28 - 167	65 - 130	30	2	2	0.18
trans-1,2-Dichloroethene	65 - 130	65 - 130	30	2	2	0.11
1,2-Dichloropropane	44 - 156	65 - 130	30	2	2	0.17
cis-1,3-Dichloropropene	22 - 178	65 - 130	30	2	2	0.21
trans-1,3-Dichloropropene	22 - 178	65 - 130	30	2	2	0.06
Methylene chloride	D - 193	65 - 130	30	2	2	0.11
1,1,2,2-Tetrachloroethane	8 - 184	65 - 130	30	2	2	0.17
Tetrachloroethene	26 - 162	65 - 130	30	2	2	0.07
1,1,1-Trichloroethane	41 - 138	65 - 130	30	2	2	0.29
1,1,2-Trichloroethane	39 - 136	65 - 130	30	2	2	0.11
Trichloroethene	35 - 146	65 - 130	30	2	2	0.14

TABLE 3-1B Volatile Organic Compounds by Methods 601/8010B

	—Accuracy—		Precision	—MQL—		
Parameter	**Aqueous %R**	**Solid %R**	**Max RPD**	**Aqueous (µg/L)**	**Solid (µg/kg)**	**MDL (µg/L)**
Trichlorofluoromethane	21 - 156	65 - 130	30	2	2	0.31
Vinyl chloride	28 - 163	65 - 130	30	2	2	0.14
SURROGATES						
1,4-Dichlorobutane	65 - 130	65 - 130	NA	NA	NA	NA

TABLE 3-1C *Volatile Organic Compounds by Method 602/8021*

	---Accuracy---		Precision	---MQL---		
Parameter	*Aqueous %R*	*Solid %R*	*Max RPD*	*Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
Benzene	*39 - 150*	*39 - 147*	*30*	*2*	*5*	*0.28*
Toluene	*46 - 148*	*46 - 148*	*30*	*2*	*5*	*0.13*
Ethyl benzene	*32 - 160*	*41 - 145*	*30*	*2*	*5*	*0.20*
Chlorobenzene	*55 - 135*	*48 - 140*	*30*	*2*	*5*	*0.11*
1,4-Dichlorobenzene	*42 - 143*	*48 - 140*	*30*	*2*	*5*	*0.11*
1,3-Dichlorobenzene	*50 - 141*	*48 - 140*	*30*	*2*	*5*	*0.24*
1,2-Dichlorobenzene	*37 - 154*	*48 - 140*	*30*	*2*	*5*	*0.14*
m,p-Xylene	69 - 127	40 - 156	30	2	5	0.23
o-Xylene	69 - 121	43 - 147	30	2	5	0.09
SURROGATES						
1,1,1-Trifluorotoluene	65 - 130	42 - 123	NA	NA	NA	NA

TABLE 3-1D *Volatile Organic Compounds by Method 603/8030A*

	—Accuracy—		Precision	—MQL—		
Parameter	Aqueous %R	Solid %R	Max RPD	Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
Acrolein	70 - 130	65 - 130	30	20	20	2.02
Acrylonitrile	70 - 130	65 - 130	30	20	20	0.80
SURROGATES						
1,1,1-Trifluorotoluene	65 - 120	65 - 120	NA	NA	NA	NA

TABLE 3-1E *Volatile Organic Compounds by Method 8260B*

Parameter	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
Benzene	*70 - 130*	*70 - 130*	*30*	*1*	*5*	*0.08*
Bromobenzene	*70 - 130*	*70 - 130*	*30*	*1*	*5*	*0.07*
Bromochloromethane	*70 - 130*	*70 - 130*	*30*	*1*	*5*	*0.12*
Bromodichloromethane	*70 - 130*	*70 - 130*	*30*	*1*	*5*	*0.09*
Bromoform	*70 - 130*	*70 - 130*	*30*	*1*	*5*	*0.07*
Bromomethane	*70 - 130*	*70 - 130*	*30*	*1*	*5*	*0.08*
n-Butylbenzene	70 - 130	70 - 130	30	1	5	0.09
sec-Butylbenzene	70 - 130	70 - 130	30	1	5	0.09
tert-Butylbenzene	70 - 130	70 - 130	30	1	5	0.07
Carbon tetrachloride	70 - 130	70 - 130	30	1	5	0.07
Chlorobenzene	70 - 130	70 - 130	30	1	5	0.08
Chloroethane	70 - 130	70 - 130	30	1	5	0.03
Chloroform	70 - 130	70 - 130	30	1	5	0.09
Chloromethane	70 - 130	70 - 130	30	1	5	0.17
2-Chlorotoluene	70 - 130	70 - 130	30	1	5	0.11
4-Chlorotoluene	70 - 130	70 - 130	30	1	5	0.11
Dibromochloromethane	70 - 130	70 - 130	30	1	5	0.11
1,2-Dibromoethane	70 - 130	70 - 130	30	1	5	0.05
Dibromoethane	70 - 130	70 - 130	30	1	5	0.09
1,2-Dichlorobenzene	70 - 130	70 - 130	30	1	5	0.10
1,3-Dichlorobenzene	70 - 130	70 - 130	30	1	5	0.08
1,4-Dichlorobenzene	70 - 130	70 - 130	30	1	5	0.09
Dichlorodifluoromethane	70 - 130	70 - 130	30	1	5	0.10
1,1-Dichloroethane	70 - 130	70 - 130	30	1	5	0.11
1,2-Dichloroethane	70 - 130	70 - 130	30	1	5	0.19

TABLE 3-1E *Volatile Organic Compounds by Method 8260B*

Parameter	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
1,1-Dichloroethene	70 - 130	70 - 130	30	1	5	0.05
cis-1,2-Dichloroethene	70 - 130	70 - 130	30	1	5	0.22
trans-1,2-Dichloroethene	70 - 130	70 - 130	30	1	5	0.08
1,2-Dichloropropane	70 - 130	70 - 130	30	1	5	0.17
1,3-Dichloropropane	70 - 130	70 - 130	30	1	5	0.10
2,2-Dichloropropane	70 - 130	70 - 130	30	1	5	0.15
1,1-Dichloropropene	70 - 130	70 - 130	30	1	5	0.08
cis-1,3-Dichloropropene	70 - 130	70 - 130	30	1	5	0.06
trans-1,3-Dichloropropene	70 - 130	70 - 130	30	1	5	0.09
Ethylbenzene	70 - 130	70 - 130	30	1	5	0.08
Hexachlorobutadiene	70 - 130	70 - 130	30	1	5	0.17
Isopropylbenzene	70 - 130	70 - 130	30	1	5	0.07
4-Isopropyltoluene	70 - 130	70 - 130	30	1	5	0.07
Methylene chloride	70 - 130	70 - 130	30	1	5	0.17
Naphthalene	70 - 130	70 - 130	30	1	5	0.10
n-Propylbenzene	70 - 130	70 - 130	30	1	5	0.09
Styrene	70 - 130	70 - 130	30	1	5	0.09
1,1,1,2-Tetrachloroethane	70 - 130	70 - 130	30	1	5	0.08
1,1,2,2-Tetrachloroethane	70 - 130	70 - 130	30	1	5	0.13
Tetrachloroethene	70 - 130	70 - 130	30	1	5	0.10
Toluene	70 - 130	70 - 130	30	1	5	0.08
1,2,3-Trichlorobenzene	70 - 130	70 - 130	30	1	5	0.17
1,2,4-Trichlorobenzene	70 - 130	70 - 130	30	1	5	0.10
1,1,1-Trichloroethane	70 - 130	70 - 130	30	1	5	0.09
1,1,2-Trichloroethane	70 - 130	70 - 130	30	1	5	0.11
Trichloroethene	70 - 130	70 - 130	30	1	5	0.05

TABLE 3-1E *Volatile Organic Compounds by Method 8260B*

	---Accuracy---		Precision	---MQL---		
Parameter	*Aqueous %R*	*Solid %R*	*Max RPD*	*Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
Trichlorofluoromethane	70 - 130	70 - 130	30	1	5	0.09
1,2,3-Trichloropropane	70 - 130	70 - 130	30	1	5	0.20
1,2,4-Trimethylbenzene	70 - 130	70 - 130	30	1	5	0.10
1,3,5-Trimethylbenzene	70 - 130	70 - 130	30	1	5	0.09
trans-1,3-Dichloropropene	70 - 130	70 - 130	30	1	5	0.09
Ethylbenzene	70 - 130	70 - 130	30	1	5	0.08
Hexachlorobutadiene	70 - 130	70 - 130	30	1	5	0.17
Isopropylbenzene	70 - 130	70 - 130	30	1	5	0.07
4-Isopropyltoluene	70 - 130	70 - 130	30	1	5	0.09
Methylene chloride	70 - 130	70 - 130	30	1	5	0.09
Naphthalene	70 - 130	70 - 130	30	1	5	0.10
n-Propylbenzene	70 - 130	70 - 130	30	1	5	0.09
Styrene	70 - 130	70 - 130	30	1	5	0.09
1,1,1,2-Tetrachloroethane	70 - 130	70 - 130	30	1	5	0.08
1,1,2,2-Tetrachloroethane	70 - 130	70 - 130	30	1	5	0.13
Tetrachloroethene	70 - 130	70 - 130	30	1	5	0.10
Toluene	70 - 130	70 - 130	30	1	5	0.08
1,2,3-Trichlorobenzene	70 - 130	70 - 130	30	1	5	0.14
1,2,4-Trichlorobenzene	70 - 130	70 - 130	30	1	5	0.10
1,1,1-Trichloroethane	70 - 130	70 - 130	30	1	5	0.09
1,1,2-Trichloroethane	70 - 130	70 - 130	30	1	5	0.11
Trichloroethene	70 - 130	70 - 130	30	1	5	0.10
Trichlorofluoromethane	70 - 130	70 - 130	30	1	5	0.09
1,2,3-Trichloropropane	70 - 130	70 - 130	30	1	5	0.20
1,2,4-Trimethylbenzene	70 - 130	70 - 130	30	1	5	0.10
1,3,5-Trimethylbenzene	70 - 130	70 - 130	30	1	5	0.09

TABLE 3-1E *Volatile Organic Compounds by Method 8260B*

	---Accuracy---		Precision	---MQL---		
Parameter	*Aqueous %R*	*Solid %R*	*Max RPD*	*Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
Vinyl chloride	70 - 130	70 - 130	30	1	5	0.07
m,p-Xylene	70 - 130	70 - 130	30	1	5	0.15
o-Xylene	70 - 130	70 - 130	30	1	5	0.07
SURROGATES						
1,2-Dichloroethane-$_{d4}$	80 - 120	80 - 120	NA	NA	NA	NA
Toluene-$_{d8}$	88 - 110	81 - 117	NA	NA	NA	NA
4-Bromofluorobenzene	86 - 115	74 - 121	NA	NA	NA	NA

TABLE 3-2A *Semivolatile Organic Compounds by Method 504*

Parameter	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
EDB	80 - 120	NA	20	0.2	NA	0.003
DBCP	80 - 120	NA	20	0.2	NA	0.001

TABLE 3-2B *Semivolatile Organic Compounds by Method 531.1*

Parameter	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
Aldicarb	70 - 130	NA	30	10	NA	3.77
Aldicarb sulfone	70 - 130	NA	30	10	NA	5.36
Aldicarb sulfoxide	70 - 130	NA	30	10	NA	3.74
Carbaryl	70 - 130	NA	30	10	NA	4.15
Carbofuran	70 - 130	NA	30	10	NA	6.97
3-Hydroxycarbofuran	70 - 130	NA	30	10	NA	8.42
Methiocarb	70 - 130	NA	30	10	NA	5.36
Methomyl	70 - 130	NA	30	10	NA	4.32

TABLE 3-2C Semivolatile Organics (Pesticides/PCBs)by Methods 608/8081/8082

Parameter	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
Aldrin	42 - 122	34 - 122	30	0.5	10	0.002
alpha-BHC	37 - 134	25 - 140	30	0.5	10	0.001
beta-BHC	17 - 147	17 - 156	30	0.5	10	0.002
delta-BHC	19 - 140	10 - 147	30	0.5	10	0.002
gamma-BHC (Lindane)	32 - 127	32 - 137	30	0.5	10	0.001
Chlordane (total)	45 - 119	50 - 130	30	0.5	10	0.060
4,4'-DDD	31 - 141	45 - 157	30	0.5	10	0.002
4,4'-DDE	30 - 145	37 - 149	30	0.5	10	0.002
4,4'-DDT	25 - 160	23 - 134	30	0.5	10	0.004
Dieldrin	36 - 146	30 - 139	30	0.5	10	0.002
Endosulfan I	45 - 153	48 - 163	30	0.5	10	0.004
Endosulfan II	D - 202	10 - 170	30	0.5	10	0.005
Endosulfan sulfate	26 - 144	30 - 149	30	0.5	10	0.004
Endrin	30 - 147	30 - 156	30	0.5	10	0.005
Endrin aldehyde	70 - 130	42 - 135	30	0.5	10	0.006
Heptachlor	34 - 111	35 - 130	30	0.5	10	0.001
Heptachlor epoxide	37 - 142	42 - 140	30	0.5	10	0.002
Methoxychlor	70 - 130	70 - 130	30	0.5	10	0.019
Toxaphene	41 - 126	45 - 140	30	0.5	100	0.09
PCB-1016	50 - 114	50 - 114	30	0.5	100	0.08
PCB-1221	15 - 178	19 - 145	30	0.5	100	0.12
PCB-1232	10 - 215	10 - 180	30	0.5	100	0.09
PCB-1242	39 - 150	39 - 150	30	0.5	100	0.11
PCB-1248	38 - 158	49 - 147	30	0.5	100	0.07
PCB-1254	29 - 131	25 - 129	30	0.5	100	0.07

TABLE 3-2C *Semivolatile Organics (Pesticides/PCBs)by Methods 608/8081/8082*

	---Accuracy---		Precision	---MQL---		
Parameter	*Aqueous %R*	*Solid %R*	*Max RPD*	*Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
PCB-1260	8 - 127	15 - 138	30	0.5	100	0.14
PCB-1268	70 - 130	70 - 130	30	0.5	100	0.06
SURROGATES						
TCMX	54 - 140	24 - 130	NA	NA	NA	NA

TABLE 3-2D *Semivolatile Organics (Polynuclear Aromatics) by Method 610/8100*

	---Accuracy---		Precision	---MQL---		
Parameter	*Aqueous %R*	*Solid %R*	*Max RPD*	*Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
Naphthalene	30 - 120	20 - 120	30	1	500	0.13
Acenaphthylene	30 - 120	20 - 120	30	1	500	0.15
Acenaphthene	30 - 120	20 - 120	30	1	500	0.21
Fluorene	30 - 120	20 - 120	30	1	500	0.15
Phenanthrene	30 - 120	20 - 120	30	1	500	0.10
Anthracene	30 - 120	20 - 120	30	1	500	0.10
Fluoranthene	30 - 120	20 - 120	30	1	500	0.10
Pyrene	30 - 120	20 - 120	30	1	500	0.08
Benzo(a)anthracene	30 - 120	20 - 120	30	1	500	0.08
Chrysene	30 - 120	20 - 120	30	1	500	0.15
Benzo(b)fluoranthene	30 - 120	20 - 120	30	1	500	0.12
Benzo(k)fluoranthene	30 - 120	20 - 120	30	1	500	0.13
Benzo(a)pyrene	30 - 120	20 - 120	30	1	500	0.14
Indeno(1,2,3-cd)pyrene	30 - 120	20 - 120	30	1	500	0.11
Dibenzo(a,h)anthracene	30 - 120	20 - 120	30	NE	NE	0.10
Benzo(g,h,i)perylene	30 - 120	20 - 120	30	1	500	0.20
		SURROGATES				
o-Terphenyl	30 - 120	20 - 120	NA	NA	NA	NA

TABLE 3-2E *Semivolatile Organics by Method 625/8270C*

Parameter	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
Phenol	*5 - 112*	*5 - 112*	*30*	*20*	*400*	*0.69*
2-Chlorophenol	*23 - 134*	*23 - 134*	*30*	*20*	*400*	*0.58*
2-Nitrophenol	*29 - 182*	*29 - 182*	*30*	*20*	*400*	*2.22*
2,4-Dimethylphenol	*32 - 119*	*32 - 119*	*30*	*20*	*400*	*1.26*
2,4-Dichlorophenol	*39 - 135*	*39 - 135*	*30*	*20*	*400*	*2.56*
4-chloro-3-methylphenol	*22 - 147*	*22 - 147*	*30*	*20*	*400*	*2.32*
2,4,6-Trichlorophenol	*37 - 144*	*37 - 144*	*30*	*20*	*400*	*1.46*
2,4-Dinitrophenol	*D - 191*	*D - 191*	*30*	*20*	*400*	*2.54*
4-Nitrophenol	*D - 132*	*D - 132*	*30*	*20*	*400*	*1.42*
2-Methyl-4,6-dinitrophenol	*D - 181*	*D - 181*	*30*	*20*	*400*	*2.78*
Pentachlorophenol	*14 - 176*	*14 - 176*	*30*	*20*	*400*	*2.87*
Pyridine	*70 - 130*	*70 - 130*	*30*	*10*	*200*	*0.83*
n-Nitrosodimethyl amine	70 - 130	70 - 130	30	10	200	1.21
bis (2-Chloroethyl) ether	12 - 158	12 - 158	30	10	200	0.44
1,3-Dichlorobenzene	D - 172	D - 172	30	10	200	0.42
1,4-Dichlorobenzene	20 - 124	20 - 124	30	10	200	0.23
1,2-Dichlorobenzene	32 - 129	32 - 129	30	10	200	0.24
bis (2-Chloroisopropyl) ether	36 - 166	36 - 166	30	10	200	0.41
n-Nitroso-di-n-propylamine	D - 230	D - 230	30	10	200	0.41
Hexachloroethane	40 - 113	40 - 113	30	10	200	0.45
Nitrobenzene	35 - 180	35 - 180	30	10	200	1.25
Isophorone	21 - 196	21 - 196	30	10	200	1.06
bis (2-Chloroethoxy) methane	33 - 184	33 - 184	30	10	200	0.80
1,2,4-Trichlorobenzene	44 - 142	44 - 142	30	10	200	0.95
Naphthalene	21 - 133	21 - 133	30	10	200	0.74

TABLE 3-2E *Semivolatile Organics by Method 625/8270C*

Parameter	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
Hexachlorobutadiene	24 - 116	24 - 116	30	10	200	0.85
Hexachlorocyclopentadiene	70 - 130	70 - 130	30	10	200	1.76
2-Chloronaphthalene	60 - 118	60 - 118	30	10	200	0.58
Dimethyl phthalate	D - 112	D - 112	30	10	200	0.37
Acenaphthylene	33 - 145	33 - 145	30	10	200	0.36
2,6-Dinitrotoluene	50 - 158	50 - 158	30	10	200	0.79
Acenaphthene	47 - 145	47 - 145	30	10	200	0.25
2,4-Dinitrotoluene	39 - 139	39 - 139	30	10	200	1.29
Diethyl phthalate	D - 114	D - 114	30	10	200	0.43
Fluorene	59 - 121	59 - 121	30	10	200	0.56
4-Chlorophenyl phenyl ether	25 - 158	25 - 158	30	10	200	0.54
n-Nitrosodiphenylamine	70 - 130	70 - 130	30	10	200	1.09
1,2-Diphenylhydrazine	70 - 130	70 - 130	30	10	200	0.91
4-Bromophenyl phenyl ether	53 - 127	53 - 127	30	10	200	1.08
Hexachlorobenzene	D - 152	D - 152	30	10	200	0.96
Phenanthrene	54 - 120	54 - 120	30	10	200	0.59
Anthracene	27 - 133	27 - 133	30	10	200	0.99
Benzo(a)anthracene	33 - 143	33 - 143	30	10	200	1.51
di-n-Butylphthalate	1 - 118	1 - 118	30	10	200	1.11
Fluoranthene	26 - 137	26 - 137	30	10	200	1.30
Benzidine	70 - 130	70 - 130	30	10	200	2.75
Pyrene	52 - 115	52 - 115	30	10	200	0.97
Benzyl butyl phthalate	D - 152	D - 152	30	10	200	1.83
3,3-Dichlorobenzidine	D - 262	D - 262	30	10	200	1.66
Chrysene	17 - 168	17 - 168	30	10	200	0.43
bis(2-Ethylhexyl)phthalate	8 - 158	8 - 158	30	10	200	1.48

TABLE 3-3A *METALS ANALYZED BY ICP-MS*

Parameter	Method(s)	—Accuracy— Aqueous %R	Solid %R	Precision Max RPD	—MQL— Aqueous[1] (µg/L)	Solid2 (µg/kg)	MDL (µg/L)
Aluminum (Al)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	2.23
Antimony (Sb)	200.8/6020	75 - 125	75 - 125	20	1.00	0.10	0.11
Arsenic (As)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	0.28
Barium (Ba)	200.8/6020	75 - 125	75 - 125	20	5.00	1.00	0.20
Beryllium (Be)	200.8/6020	75 - 125	75 - 125	20	1.00	0.10	0.08
Boron (B)	200.8/6020	75 - 125	75 - 125	20	10.0	1.00	0.23
Cadmium (Cd)	200.8/6020	75 - 125	75 - 125	20	1.00	0.10	0.14
Chromium (Cr)	200.8/6020	75 - 125	75 - 125	20	5.00	1.00	0.11
Cobalt (Co)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	0.05
Copper (Cu)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	0.19
Lead (Pb)	200.8/6020	75 - 125	75 - 125	20	1.00	0.10	0.15
Manganese (Mn)	200.8/6020	75 - 125	75 - 125	20	5.00	1.00	0.13
Molybdenum (Mo)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	0.15
Nickel (Ni)	200.8/6020	75 - 125	75 - 125	20	10.0	1.00	0.26
Selenium (Se)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	1.31
Silver (Ag)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	0.12
Strontium (Sr)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	0.19
Thallium (Tl)	200.8/6020	75 - 125	75 - 125	20	1.00	0.10	0.07
Titanium (Ti)	200.8/6020	75 - 125	75 - 125	20	5.00	1.00	0.26
Tin (Sn)	200.8/6020	75 - 125	75 - 125	20	5.00	0.50	0.17
Vanadium (V)	200.8/6020	75 - 125	75 - 125	20	5.00	1.00	0.09
Zinc (Zn)	200.8/6020	75 - 125	75 - 125	20	5.00	1.00	0.44

Note 1: The stated MQLs (Minimum Quantifying Level) and MDLs (Minimum Detection Level) for ICP-MS are conservative. The values listed are highly matrix dependent and elevate or decrease depending on matrix and specific client needs.

Note 2: Other parameters can be analyzed upon client request.

ICP-MS: Inductively Coupled Plasma-Mass Spectroscopy.

[1] Based on a dilution factor of 2.0.

[2] Based on a dilution factor of 100:1.

TABLE 3-2E *Semivolatile Organics by Method 625/8270C*

Parameter	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
di-n-Octylphthalate	4 - 146	4 - 146	30	10	200	1.37
Benzo(b)fluoranthene	24 - 159	24 - 159	30	10	200	0.83
Benzo(k)fluoranthene	11 - 162	11 - 162	30	10	200	0.61
Benzo(a)pyrene	17 - 163	17 - 163	30	10	200	1.01
Indeno(1,2,3-cd)pyrene	D - 171	D - 171	30	10	200	1.25
Dibenzo(a,h)anthracene	D - 227	D - 227	30	10	200	0.99
Benzo(g,h,i)perylene	D - 219	D - 219	30	10	200	0.90
SURROGATES						
2-Fluorophenol	21 - 100	25 - 121	NA	NA	NA	NA
Phenol-$_{d6}$	10 - 94	24 - 113	NA	NA	NA	NA
2,4,6-Tribromophenol	10 - 123	19 - 122	NA	NA	NA	NA
Nitrobenzene-$_{d5}$	35 - 114	23 - 120	NA	NA	NA	NA
2-Fluorobiphenyl	43 - 116	30 - 115	NA	NA	NA	NA
p-terphenyl-$_{d14}$	33 - 141	18 - 137	NA	NA	NA	NA

TABLE 3-3B *METALS ANALYZED BY ICP-AES*

Parameter	Method(s)	—Accuracy— Aqueous %R	Solid %R	Precision Max RPD	—MQL— Aqueous (mg/L)	Solid[1] (mg/Kg)	MDL (mg/L)
Aluminum (Al)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.03
Antimony (Sb)	200.7/6010A	75 - 125	75 - 125	20	0.50	12.0	0.09
Arsenic (As)	200.7/6010A	75 - 125	75 - 125	20	0.50	12.0	0.09
Barium (Ba)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.002
Beryllium (Be)	200.7/6010A	75 - 125	75 - 125	20	0.004	0.63	0.001
Boron (B)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.02
Cadmium (Cd)	200.7/6010A	75 - 125	75 - 125	20	0.025	0.63	0.006
Calcium (Ca)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.02
Chromium (Cr)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.01
Cobalt (Co)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.01
Copper (Cu)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.005
Iron (Fe)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.007
Lead (Pb)	200.7/6010A	75 - 125	75 - 125	20	0.50	12.0	0.06
Magnesium (Mg)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.001
Manganese (Mn)	200.7/6010A	75 - 125	75 - 125	20	0.050	1.25	0.001
Molybdenum (Mo)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.03
Nickel (Ni)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.03
Potassium (K)	200.7/6010A	75 - 125	75 - 125	20	2.00	50.0	0.58
Phosphorus (P)	200.7/6010A	75 - 125	75 - 125	20	0.30	7.50	0.05
Selenium (Se)	200.7/6010A	75 - 125	75 - 125	20	0.50	12.0	0.17
Silicon (Si)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	
Silver (Ag)	200.7/6010A	75 - 125	75 - 125	20	0.050	1.25	0.008
Sodium (Na)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.06
Strontium (Sr)	200.7/6010A	75 - 125	75 - 125	20	0.010	0.25	0.001
Sulfur (S)	200.7/6010A	75 - 125	75 - 125	20	0.50	12.0	0.10

TABLE 3-3B *METALS ANALYZED BY ICP-AES*

Parameter	Method(s)	—Accuracy— Aqueous %R	Solid %R	Precision Max RPD	—MQL— Aqueous (mg/L)	Solid[1] (mg/Kg)	MDL (mg/L)
Thallium (Tl)	200.7/6010A	75 - 125	75 - 125	20	0.50	12.0	0.20
Titanium (Ti)	200.7/6010A	75 - 125	75 - 125	20	0.10	2.50	0.003
Tin (Sn)	200.7/6010A	75 - 125	75 - 125	20	0.50	12.0	0.09
Vanadium (V)	200.7/6010A	75 - 125	75 - 125	20	0.050	1.25	0.03
Zinc (Zn)	200.7/6010A	75 - 125	75 - 125	20	0.050	1.25	0.002

Note: The MQLs (Minimum Quantifying Level) were established as the minimum levels, which could accurately be quantified with, and acceptable degree of precision. The MQLs are matrix dependent and the values are for guidance and may not always be achievable. The stated MDLs (Minimum Detection Level) for ICP-AES are conservative.

ICP-AES: Inductively Coupled Plasma-Atomic Emission Spectroscopy.

[1] Based on a dilution factor of 25:1.

TABLE 3-3C *METALS ANALYZED BY GFAA*

Parameter	Method(s)	—Accuracy— Aqueous %R	Solid %R	Precision Max RPD	—MQL— Aqueous (mg/L)	Solid[1] (mg/Kg)	MDL (mg/L)
Aluminum (Al)	202.2	75 - 125	75 - 125	20	0.010	0.25	—[2]
Antimony (Sb)	204.2/7041	75 - 125	75 - 125	20	0.010	0.25	0.001
Arsenic (As)	206.2/7060A	75 - 125	75 - 125	20	0.010	0.25	0.001
Beryllium (Be)	210.2/7091	75 - 125	75 - 125	20	0.001	0.025	0.0002
Cadmium (Cd)	213.2/7131A	75 - 125	75 - 125	20	0.001	0.025	0.0002
Chromium (Cr)	218.2/7191	75 - 125	75 - 125	20	0.010	0.25	0.001
Chromium $^{+6}$	218.5/7195 218.4/7196	75 - 125 75 - 125	75 - 125 75 - 125	20 20	0.010 0.010	0.25 0.20	0.001 —[2]
Cobalt (Co)	219.2/7201	75 - 125	75 - 125	20	0.010	0.25	—[2]
Copper (Cu)	220.2/7211	75 - 125	75 - 125	20	0.010	0.25	—[2]
Lead (Pb)	239.2/7421	75 - 125	75 - 125	20	0.010	0.25	0.001
Manganese (Mn)	243.2/7461	75 - 125	75 - 125	20	0.002	0.050	—[2]
Molybdenum (Mo)	246.2/7481	75 - 125	75 - 125	20	0.010	0.12	0.004
Nickel (Ni)	249.2	75 - 125	75 - 125	20	0.010	0.25	0.005
Selenium (Se)	270.2/7740	75 - 125	75 - 125	20	0.010	0.25	0.002
Silver (Ag)	272.2/7761	75 - 125	75 - 125	20	0.001	0.025	—[2]
Thallium (Tl)	279.2/7841	75 - 125	75 - 125	20	0.005	0.12	0.001
Tin (Sn)	282.2	75 - 125	75 - 125	20	0.010	0.25	0.002
Titanium (Ti)	283.2	75 - 125	75 - 125	20	0.010	0.25	—[2]
Vanadium (V)	286.2/7911	75 - 125	75 - 125	20	0.010	0.25	—[2]

Note: The MQLs (Minimum Quantifying Level) were established as the minimum levels, which could accurately be quantified with, and acceptable degree of precision. The listed MQLs are matrix dependent and are for guidance only; they may not always be achievable.

GFAA: Graphite Furnace Atomic Absorption

[1] Based on a dilution factor of 25:1.

[2] Have not been determined.

TABLE 3-3D *METALS ANALYZED BY FAA*

Parameter	Method(s)	—Accuracy— Aqueous %R	Solid %R	Precision Max RPD	—MQL— Aqueous (mg/L)	Solid[1] (mg/kg)	MDL (mg/L)
Aluminum (Al)	202.1/7020	75 - 125	75 - 125	20	1.00	25.0	—[4]
Antimony (Sb)	204.1/7040	75 - 125	75 - 125	20	0.50	12.0	—[4]
Arsenic (As)[2]	206.3/7061A	75 - 125	75 - 125	20	0.005	0.12	—[4]
Barium (Ba)	208.1/7080A	75 - 125	75 - 125	20	1.00	25.0	—[4]
Beryllium (Be)	210.1/7090	75 - 125	75 - 125	20	0.050	1.25	—[4]
Cadmium (Cd)	213.1/7130	75 - 125	75 - 125	20	0.025	0.63	0.002
Calcium (Ca)	215.1/7140	75 - 125	75 - 125	20	0.10	2.50	—[4]
Chromium (Cr)	218.1/7190	75 - 125	75 - 125	20	0.20	5.00	—[4]
Cobalt (Co)	219.1/7200	75 - 125	75 - 125	20	0.10	2.50	—[4]
Copper (Cu)	220.1/7210	75 - 125	75 - 125	20	0.10	2.50	0.002
Iron (Fe)	236.1/7380	75 - 125	75 - 125	20	0.10	2.50	—[4]
Lead (Pb)	239.1/7420	75 - 125	75 - 125	20	0.25	6.25	0.04
Magnesium (Mg)	242.1/7450	75 - 125	75 - 125	20	0.10	2.50	—[4]
Manganese (Mn)	243.1/7460	75 - 125	75 - 125	20	0.050	1.25	—[4]
Mercury (Hg)[3]	245.1/7470A	70 - 130	70 - 130	20	0.001	0.10	0.0002
Molybdenum (Mo)	246.1/7480	75 - 125	75 - 125	20	1.00	25.0	—[4]
Nickel (Ni)	249.1/7520	75 - 125	75 - 125	20	0.10	2.50	—[4]
Potassium (K)	258.1/7610	75 - 125	75 - 125	20	0.10	2.50	0.003
Selenium (Se)[2]	270.3/7741A	75 - 125	75 - 125	20	0.005	0.12	—[4]
Silicon (Si)	SM 3111D	75 - 125	75 - 125	20	5.00	125	—[4]
Silver (Ag)	272.1/7760A	75 - 125	75 - 125	20	0.050	1.25	—[4]
Sodium (Na)	273.1/7770	75 - 125	75 - 125	20	0.10	2.50	—[4]
Thallium (Tl)	279.1/7840	75 - 125	75 - 125	20	0.50	12.0	—[4]
Titanium (Ti)	283.1	75 - 125	75 - 125	20	2.00	50.0	—[4]
Tin (Sn)	282.1/7870	75 - 125	75 - 125	20	4.00	100	—[4]

TABLE 3-3D *METALS ANALYZED BY FAA*

Parameter	Method(s)	—Accuracy— Aqueous %R	Solid %R	Precision Max RPD	—MQL— Aqueous (mg/L)	Solid[1] (mg/kg)	MDL (mg/L)
Vanadium (V)	286.1/7910	75 - 125	75 - 125	20	1.00	25.0	—[4]
Zinc (Zn)	289.1/7950	75 - 125	75 - 125	20	0.020	0.50	—[4]

Note: The MQLs (Minimum Quantifying Level) were established as the minimum levels, which could accurately be quantified with, and acceptable degree of precision. The listed MQLs are matrix dependent and are for guidance only; they may not always be achievable.

[1] Based on a dilution factor of 25:1.
[2] Analysis by Hydride Generation.
[3] Analysis by CVAA.
[4] Has not been determined.

TABLE 3-4A *INORGANIC ANALYTES (Classical Chemistry)*

Parameter	*Method*	*---Accuracy--- Aqueous %R*	*Solid %R*	*Precision Max RPD*	*---MQL--- Aqueous (µg/L)*	*Solid (µg/kg)*	*MDL (µg/L)*
Acidity	*SM2310B*	*80 - 120*	*80 - 120*	*20*	*1.0*	*10.0*	*NA*
Alkalinity	*SM2320B*	*80 - 120*	*80 - 120*	*20*	*1.0*	*10.0*	*1*
Ammonia	*SM4500NH$_3$ B&E*	*80 - 120*	*80 - 120*	*20*	*0.10*	*1.0*	*0.11*
Bicarbonate	*SM2320B*	*80 - 120*	*80 - 120*	*20*	*1*	*10.0*	*NA*
BOD$_5$ Day	*SM5210B*	*80 - 120*	*80 - 120*	*20*	*2*	*NA*	*NA*
Bromide	*SM4500 Br⁻ B*	*80 - 120*	*80 - 120*	*20*	*0.10*	*1.0*	*0.3*
COD	*EPA 410.4*	*80 - 120*	*80 - 120*	*20*	*10*	*10*	*3*
Chloride	*EPA 300*	*80 - 120*	*80 - 120*	*20*	*1.0*	*10*	*0.3*
Chlorine, Residual	*SM4500 Cl G*	*80 - 120*	*80 - 120*	*20*	*0.20*	*NA*	*NA*
Conductivity	*SM2510B*	*80 - 120*	*80 - 120*	*20*	*1.0 umhos*	*1.0 umhos*	*0.9*
Carbon, Total Fixed	*ASTM D-3174 & 75,D2961/ SM2540E*	*80 - 120*	*80 - 120*	*20*	*1.0%*	*1.0%*	*NA*
Carbon, Total	*EPA 9060*	*80 - 120*	*80 - 120*	*20*	*1.0*	*1.0*	*NA*
Carbon, Inorganic	*EPA 9060*	*80 - 120*	*80 - 120*	*20*	*1.0*	*1.0*	*NA*
Carbon, Organic	*EPA 9060*	*80 - 120*	*80 - 120*	*20*	*1.0*	*1.0*	*NA*
Color	*SM2120B*	*80 - 120*	*80 - 120*	*20*	*5 color units*	*NA*	*NA*

TABLE 3-4A INORGANIC ANALYTES (Classical Chemistry)

		---Accuracy---		Precision	---MQL---		
Parameter	**Method**	**Aqueous %R**	**Solid %R**	**Max RPD**	**Aqueous (µg/L)**	**Solid (µg/kg)**	**MDL (µg/L)**
Cyanide, Total	SM4500 CN C&E	80 - 120	80 - 120	20	0.02	1.0	0.001
Dissolved Oxygen	SM4500-O C	80 - 120	80 - 120	20	1.0	NA	NA
Fluoride	EPA300/SM4500-FC	80 - 120	80 - 120	20	0.10	1.0	0.02
Formaldehyde	NIOSH 3500	80 - 120	80 - 120	20	0.025	0.25	NE
Hardness	SM2340B	80 - 120	80 - 120	20	0.1	NA	NA
Hydrogen Sulfide	SM4500 S^{2-} F	80 - 120	80 - 120	20	5.0	NA	NA
Ignitability	Pensky Martin	80 - 120	80 - 120	20	NA	NA	NA
Nitrogen, TKN	EPA 351.3	80 - 120	80 - 120	20	0.10	1.0	0.24
Nitrate-Nitrite	EPA 300	80 - 120	80 - 120	20	0.50	5.0	0.07
Nitrate	EPA 300	80 - 120	80 - 120	20	0.10	1.0	0.02
Nitrite	EPA 300	80 - 120	80 - 120	20	0.50	5.0	0.05
Odor	SM2150B	80 - 120	80 - 120	20	TON*	TON*	NA
Oil & Grease	SM5520B	80 - 120	80 - 120	20	5	NA	NA
Nitrogen, Organic	EPA 351.3/SM4500 NH_3 B&E	80 - 120	80 - 120	20	0.10	1.0	NA
Orthosphosphate	SM4500 PE	80 - 120	80 - 120	20	0.05	NA	0.01
pH (Hydrogen Ion)	EPA 9045A/SM4500 H^+B	80 - 120	80 - 120	20	NA	NA	NA
Phenolics, Total	EPA 420.1	80 - 120	80 - 120	20	0.005	0.05	0.002
Phosphorus, Total	SM4500 PB5&E	80 - 120	80 - 120	20	0.05	NA	0.02

TABLE 3-4A INORGANIC ANALYTES (Classical Chemistry)

Parameter	Method	---Accuracy--- Aqueous %R	Solid %R	Precision Max RPD	---MQL--- Aqueous (µg/L)	Solid (µg/kg)	MDL (µg/L)
Phosphate, Total	SM4500 PB5&E	80 - 120	80 - 120	20	0.05	NA	0.02
Reactivity (CN/S)	EPA 7.3.3.2/EPA 7.3.4.2	80 - 120	80 - 120	20	5.0 S^{2-}/1.0 CN^-	5.0 S^{2-}/ 1.0 CN^-	NA
Settleable Solids	SM2540F	80 - 120	80 - 120	20	0.1mL/L	NA	NA
Sulfate	EPA 300	80 - 120	80 - 120	20	5	50	4.5
Specific Gravity	SM2710F	80 - 120	80 - 120	20	NA	NA	NA
Sulfide	SM4500 S^{2-} E	80 - 120	80 - 120	20	0.1	5.0	NA
Sulfite	SM4500 SO_3^{2-}E	80 - 120	80 - 120	20	2.0	20	NA
TDS	SM5540C	80 - 120	80 - 120	20	1	NA	1
TS	SM2540C	80 - 120	80 - 120	20	1	NA	1
TSS	SM2540B	80 - 120	80 - 120	20	1	1	1
Surfactants (MBAS)	SM5540C	80 - 120	80 - 120	20	1	NA	0.03
Turbidity	SM2130B	80 - 120	80 - 120	20	0.05 NTU	NA	NA
Volatile Solids	SM2540B	80 - 120	80 - 120	20	1	1	1
Fecal Coliform	SM9222D	NA	NA	NA	<1	<100	NA
Fecal Streptocci	SM9230C	NA	NA	NA	<1	<100	NA
Fecal (MPN)	SM9221C	NA	NA	NA	<1	<100	NA
Total Coliform	SM9222B	NA	NA	NA	<1	<100	NA

List of Abbreviations:

%R - ***Percent Recovery Range for Spike Analytes***
Max RPD - ***Maximum Relative Percent Difference***
MDL - ***Method Detection Limit***
NA - ***Not Applicable***
NE - ***Note Established***

Section 4.0

Sampling Procedures

4.0 Sampling Procedures

4.1 Preparation of Field Sampling Operations: Prior to any field operations, the project manager and field team personnel will review the project work plan and the associated QAPP. These documents should be referenced for specific information concerning equipment, supplies, and sampling procedures. The field sampling procedures included in these documents include: documentation requirements, sample collection, preservation, packaging, shipping, and equipment decontamination.

The following procedures are followed in preparation for field sampling operations:

1. The project manager and the field team review the work plan and site- specific QA plan.
2. The project manager must coordinate schedules/actions with the sampling site officer (contracting officer or designate).
3. Appropriate permission for property access is obtained.
4. The equipment and supplies are assembled. Appropriate operation of all field equipment is checked.
5. The project manager conducts a pre-field meeting or a conference call. This is designed to enable all field team members and the laboratory personnel to be aware of the project specific requirements and schedules.
6. A bound field notebook(s) is developed consisting of all types of forms needed for field sampling activities. Extra forms are included in the notebook(s). Also included is a map of proposed sampling locations (i.e., monitoring well locations, soil boring locations).
7. The project manager must address field safety issues in advance of field sampling activities.

4.2 *GROUNDWATER SAMPLING OPERATIONS*

4.2.1 *MONITORING WELL SAMPLING*

4.2.1.1 *Well Purging Techniques*

Water Level and Purge Volume: Locate the monitoring wells to be sampled and appropriate decontamination area. In most cases field decontamination may not be necessary. All equipment shall be pre-cleaned in-house and transported to the field ready for use. Locate staging areas and areas for managing the purged water. If field cleaning is required, decontaminate all sampling equipment before taking the first sample and between sampling intervals.

Sample monitoring wells from the least to the most contaminated to reduce the possibility of cross-contamination. Unlock the well and use a stiff brush to brush away any dirt or debris from around the well cap. Remove the cap. Use a petroleum detection probe to determine the presence of any floating organics in the wellbore water column. You can also use the probe to determine the total depth of the well and depth to water.

To ensure obtaining a representative groundwater sample from a potable well or monitoring well, it is essential that the well be purged prior to sampling. Stagnant water in a well casing may undergo a variety of chemical changes due to alterations in the redox potential, the pH, and adsorption of compounds in the water column casing. Three to 5 well volumes of water should be purged prior to sampling. For most wells, removal of 3 to 5 well volumes and/or until the pH, conductivity, and temperature readings of the groundwater stabilize constitute an adequate purging.

In order to calculate the purge volume, the water level is determined by using an electronic probe, chalked tape, etc., that has been properly cleaned. The probe is lowered down the well until the indicator sounds. The depth to water from the mark on the well casing is measured and recorded in the logbook. The amount of water in the well (casing or bore volume) is calculated using the following formula:

$$[(\pi)*(d^2)/\ (h1 - h2)*(7.48)] = \text{gallons / bore volume}$$

where:

π	=	*pi = 3.1416*
d	=	*inner diameter of a well bore (ft)*
h_1	=	*depth of well from top of well casing (ft)*
h_2	=	*depth to water from top of casing (ft)*
bore volume	=	*volume of water equivalent to standing water in a well.*

All sampling information is recorded in the Groundwater Sampling Log **(Figure 4-1)**.

FIGURE 4.1 REI CONSULTANTS GROUNDWATER SAMPLING LOG

Project Name: **Project #:** **Well #:**

Contact Person: **Phone #:**

WELL CONDITION DATA

	Y	N		Y	N
Protective Casing Present			**Physical Damage**		
Protective Casing Locked			**Concrete/Grout Pad Present**		
Cap on Well Riser			**2" PVC Casing**		

If yes, Describe:

PURGING DATA

Date/Time: **Weather Conditions:**

Static Depth (Depth to Water)	**(Ft)**	**Volume**	**(Liters)**
Well Depth	**(Ft)**	**3 Volumes**	**(Liters)**
Water Column Height	**(Ft)**	**Volume Purged**	**(Liters)**

EVACUATION/STABILIZATION TEST DATA

Time	pH (SU)	Temperature Corrected Conductivity (umhos/cm)	Temperature (°C)	Turbidity (NTU)	Volume Purged (Liters)

SAMPLING DATA

Date: **Time:**

Method: **Sampling Depth:**

Temperature: **(°C)** **Turbidity:** **(NTU)**

Odor and Physical Appearance of Sample:

Comments:

pH:

Sampled by:

Sampler's Signature: **Date:**

Groundwater Purging Equipment and Use:

Purging a monitoring well can be performed with one of the following: Bladder Pump, Peristaltic (Suction-Lift) Pump, Centrifugal Pump, Electric and Reciprocating Piston Submersible Pumps, and Hand Pumps. The choice of equipment used for purging must not bias the "representativeness" of the sample collected. It is recommended that field personnel use pumps to purge monitoring wells. A bailer may not be used for purging because frequent lowering and retrieving of the bailer:

- May introduce atmospheric oxygen which may precipitate metals;
- May result in agitation of groundwater and volatilization of analytes which may bias volatile and semivolatile analyses; and
- May introduce suspended particles through scraping the sides of the casing.

Bladder Pump: The bladder pump (Middleburg or diaphragm) is a good choice when the well depth is beyond the capability of the peristaltic pump. Additionally, the relatively high pumping rate allows rapid well evacuation. With deep purging, large volumes of gas and longer cycles are required. Bladder pumps consist of a membrane enclosed in a stainless steel housing. Water enters the membrane through the lower check valve and compressed gas is injected into the cavity between the housing and bladder. Water is transported through an upper check valve and into a discharge line. The process is repeated to cycle the water to the surface and into the flow-through bath.

1. Attach the pump to dedicated Teflon tubing. Lower the pump down the well until it is just below the surface of the water. Attach the compressed gas and discharge lines and then adjust the cycle. Begin pumping and follow the water level down the wellbore to ensure that all of the stagnant water in the casing is removed. This may not be possible for permanently installed dedicated pumps.
2. Measure the rate of discharge frequently (every two gallons). A calibrated bucket and stopwatch are commonly used in this measurement. Purge a minimum of three casing volumes and continue purging until the discharge parameters (pH, temperature, and specific conductance) stabilize.
3. Avoid pumping the well dry. Reduce the pumping rate after the water level has fallen to the screened level for water formation.
4. Allow the well to recover to 80% of its initial volume before sampling. Use the water level probe to monitor well recovery. If the well is not recovering rapidly the project manager may choose to have the well sampled before the 80% recovery has been achieved.

Peristaltic (Suction-Lift)/ Centrifugal Pump: Using a peristaltic pump for well evacuation is particularly advantageous because the system may be used for sample collection. In addition, the flow rate is easily controlled. The pump can be used in wells of any diameter and nonplumb wells. However, the peristaltic pump can only be used in wells with a potentiometric level less than 25 ft below the land surface (BLS). Additionally, low pumping rates make it difficult to evacuate the wellbore in a reasonable amount of time. Electric power is required, and there is a high likelihood of stripping the volatile organic compounds.

The peristaltic pump is a self-priming, low-volume pump consisting of rotor and ball-bearing rollers. The rollers squeeze tubing inserted around the pump rotor as the rotor revolves. One end of precleaned tubing is placed into the well while the other end is connected to a flow through bath. As the rotor revolves, water is drawn up (one gallon per minute) from the well.

1. Lower the drop pipe down the well until it is a short distance below the water level. Begin pumping and follow the water level down the wellbore to ensure that all of the stagnant water in the casing is removed.
2. Measure the rate of discharge frequently (every two gallons). A calibrated bucket and stopwatch are commonly used in this measurement. Purge a minimum of three casing volumes and continue purging until the discharge parameters (pH, temperature, and specific conductance) stabilize.
3. Avoid pumping the well dry. Reduce the pumping rate after the water level has fallen to the screened level for water formation.
4. Allow the well to recover to 80% of its initial volume before sampling. Use the water level probe to monitor well recovery. If the well is not recovering rapidly the project manager may choose to have the well sampled before the 80% recovery has been achieved.

Electric and Reciprocating Piston Submersible Pumps: The submersible pump is commonly used for purging deep, large diameter wells requiring high pumping rates. The reciprocating piston pump can be used for purging wells with depths up to 500 ft, can be operated in 2-inch diameter wells, and operated by compressed air and self priming. The pump is constructed from stainless steel. The pump assembly is suspended from the discharge tubing and submerged in the well. Water is transported through the discharge tube to the surface by centrifugal or piston action. A portable generator (or battery) is used to supply the power. A portable air compressor is used to drive the piston-type pump.

1. Lower the pump assembly down the well until it is a short distance below the water level. Begin pumping and follow the water level down the well bore to ensure that all of the stagnant water in the casing is removed.
2. Measure the rate of discharge frequently (every two gallons). A calibrated bucket and stopwatch are commonly used in this measurement. Purge a minimum of three casing volumes and continue purging until the discharge parameters (pH, temperature, and specific conductance) stabilize.
3. Allow the well to recover to 80% of its initial volume before sampling. Use the water level probe to monitor well recovery. If the well is not recovering rapidly the project manager may choose to have the well sampled before the 80% recovery has been achieved.

Hand Pumps: Hand pumps (eg. Brainard-Kilman "B-K pump") are manual pumps that should be used for purging 2 inch diameter monitoring wells in which the static water level is too deep for use of a centrifugal or peristaltic pump. For the B-K pump, the intake is lowered to the top of the water column by attaching additional 5-foot sections onto the pump. By changing the stroke of the actuating rod the pumping rate can be made compatible with the well specific yield. The B-K pump and the associated riser pipes are constructed of PVC. The lower most section of the pump is equipped with a foot valve to prevent back flow of purge water. After purging is completed, the B-K pump should be completely disassembled and decontaminated.

4.2.1.2 Groundwater Sampling Procedures

Some pumps may be used for sampling groundwater, but are not recommended. The all-Teflon and stainless steel bladder pump is the only non-dedicated pump that can be approved for sampling all parameters, including volatile samples. The preferred approach is to purge the monitoring well with a pump but collect the groundwater samples with a bailer.

It is recommended that prior to sampling, the first bailer amount of groundwater be discarded or "wasted" to acclimate the bailer. The following procedure describes general bailer techniques:

1. Field personnel should wear natural latex (not PVC or nitrile) gloves to avoid sample contamination.
2. Attach a fresh length of monofilament or braided nylon line to the bailer. Alternatively, a precleaned permanent lanyard may be used.
3. The bailer or lanyard must not be allowed to touch the ground during purging or sampling.
4. Slowly lower the bailer into the well until it contacts the water surface such that agitation of the water column is minimized. Attempt to sample from the same depth each time.
5. Slowly retrieve the bailer out of the well. Collecting the lanyard between the thumbs of each hand seems to be the preferred method.
6. Discard the first few inches of water in the bailer and fill the appropriate container so that minimum turbulence is created to avoid aeration.
7. Tip the bailer to allow a slow discharge to flow gently down the inside wall of the sample bottle with minimal entry turbulence. Use of the bottom emptying device is not recommended. Discard the last few inches of water in the bailer.
8. Samples for laboratory analyses should be protected from sunlight to prevent photolytic decomposition.

Groundwater Sampling for VOCs

1. Samples for VOCs analysis should be collected in 40 mL glass vials with Teflon-lined caps. Visually inspect a 40 ml (or 60 ml) glass vial to assure that there are no glass or septum defects. If defects are present and/or the sample container does not appear to be clean, the vial should be discarded.
2. Vials should have a sufficient amount of 1:1 HCl preservative if the aromatic fraction will require greater than a 7-day holding time. Vials may be pre-preserved or field preserved.
3. Wear natural latex gloves and bail the water from the well. Remove the cap from the glass vial without contacting the Teflon lined septum.
4. Do not allow the bailer to touch the rim of the sample container.
5. Fill the vial by pouring down the edge to minimize aeration until a convex meniscus is formed above the vial rim.
6. Quickly place the Teflon side of the lined septa and cap over the convex meniscus and tighten securely.
7. Invert the sample vial and gently tap in palm of hand to check for air bubble presence. If small air bubbles are present, remove the cap and remove the bubbles by pouring additional water into the vial or discard this vial and start again. Adding more sample should be attempted at a maximum of three times before the vial must be discarded.
8. Affix a sample label to the vial. Wrap the vial in bubble-wrap or equivalent to prevent breakage.
9. Place the vial in a sealed plastic (ziplock-type) bag.
10. Place the sealed vial(s) in an ice cooler on wet ice and complete the chain-of-custody form prior to transporting them to the laboratory.

Sampling for Extractable Organics, Pesticides and Herbicides

1. Samples for extractable organics should be collected in 1-liter amber glass containers with Teflon-lined caps. Visually inspect the container to assure that there are no glass or liner defects. If defects are present and/or the sample container does not appear to be clean, the container should be discarded.
2. If pesticide samples will not be analyzed within 72 hours, field personnel should add sufficient amount of H_2SO_4 or NaOH preservative into the glass containers to bring the pH to 5-9 prior to transporting them from the field. Other extractable samples need not be pH-adjusted with acid or base.
3. Wear natural latex gloves and bail the water from the well. Remove the cap from the glass vial without contacting the Teflon liner.
4. Do not allow the bailer to touch the rim of the sample container. Fill the bottle to almost full capacity.
5. Quickly place the Teflon lined cap over the bottle and tighten securely.
6. Affix a sample label to the glass bottle. Wrap the vial in bubble-wrap or equivalent to prevent breakage.
7. Place the wrapped bottle in a sealed plastic (ziplock-type) bag.
8. Place the sealed bottle(s) in an ice cooler on wet ice and complete the chain-of-custody form prior to transporting them to the laboratory.

Groundwater Sampling for Metals Analysis

1. Samples for metals analysis should be collected in 500 mL polyethylene containers with Teflon-lined caps. Visually inspect the polyethylene containers for defects or improper decontamination. If defects are present and/or sample containers do not appear to be clean, the containers should be discarded.
2. Wear natural latex gloves and bail the water from the well. Remove the cap from the container.
3. Do not allow the bailer to touch the rim of the sample container. The bottles should not be filled to full capacity so that preservatives may be added (if applicable).
4. Acidify the samples to pH 2 or less by adding a measured quantity of concentrated HNO_3 or 1:1 HNO_3 into the container. Samples submitted for chromium should not be acidified.
5. Pour an aliquot of the acidified sample into a small dish or onto a piece of narrow range pH paper to check adequacy of preservation. Field experience has shown that 2 mLs of concentrated HNO_3 added to 250 mLs of water sample will induce a pH < 2 in most cases.
6. Record the total amount of acid added. The same amount must be added to the accompanying equipment blanks.
7. Cap the bottle and tighten securely.
8. Affix a sample label to the container, wrap the container in bubble-wrap or equivalent to prevent breakage, and complete the chain-of-custody.
9. Place the wrapped bottle in a sealed plastic (ziplock-type) bag.
10. Aqueous samples for metals need not be chilled to 4°C.

Groundwater Sampling For Oil and Grease

1. Samples for oil and grease should be collected in 1 liter amber glass containers with Teflon-lined caps. Since losses of grease will occur on sampling equipment, the collection of composite samples is impractical. Visually inspect the glass containers to assure that there are no glass or cap defects. If defects are present and/or sample containers do not appear to be clean, the containers should be discarded.
2. Field personnel should add sufficient amounts (5 mls) of HCl preservative into the glass containers if sample cannot be analyzed within a few hours.
3. Wear natural latex gloves and bail the water from the well. Remove the cap from the glass bottles without contacting the inside.
4. Do not allow the bailer to touch the rim of the sample container. Fill the bottle to almost full capacity.
5. Quickly place the cap over the bottle and tighten securely.
6. Affix a sample label to the glass bottle. Wrap the vial in bubble-wrap or equivalent to prevent breakage.
7. Place the wrapped bottle in a sealed plastic (ziplock-type) bag.
8. Place the sealed container(s) in an ice cooler on wet ice and complete the chain-of-custody form prior to transporting them to the laboratory.

Groundwater Sampling for Various Parameters

This section includes: TOC, residue, nutrients, demands, inorganic anions, and microbiological sampling.

1. Visually inspect the glass or plastic containers to assure that there are no glass or cap defects. If defects are present and/or sample containers do not appear to be clean, the containers should be discarded.
2. Wear natural latex gloves and bail the water from the well. Remove the cap from the glass bottles without contacting the inside.
3. Do not allow the bailer to touch the rim of the sample container. Fill the container to almost full capacity.
4. Add the preservatives (if required) as discussed in the section concerning metal samples.
5. Quickly place the cap over the mouth and tighten securely.
6. Affix a sample label to the container. Wrap the vial in bubble-wrap or equivalent to prevent breakage.
7. Place the wrapped container in a sealed plastic (ziplock-type) bag.
8. Place the sealed container(s) in an ice cooler on wet ice and complete the chain-of-custody form prior to transporting them to the laboratory.

4.2.1.3 Post - Sampling Operation

1. Ensure that all equipment is accounted for, decontaminated and ready for shipment.
2. Restore the site to pre-sampling conditions.
3. Prepare sample(s) for transport.
4. Record cleanup procedures and any uncompleted work in the logbook.
5. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.
6. Review data collection forms for completeness.
7. Deliver the original forms and logbooks to the project manager for technical review. The project manager must sign and date every page.
8. Contact the analytical laboratory to ensure that the samples arrived safely and all instructions for sample analyses are clearly understood.
9. Make sure all monitoring wells are properly labeled and the location ID is readily visible on the protective casing.

4.2.2 *DRINKING WATER (POTABLE WATER) SAMPLING*

Field personnel will routinely collect drinking water samples from private residential potable wells. The following procedures are to be used in the sampling of water from taps located anywhere in a water supply system:

1. If storage/pressure tanks are present, an adequate volume of water must be purged to totally exchange the volume of water in the tank. If the pump runs continuously and the sample can be collected before the water reaches the storage/pressure tank, no purging is necessary. Open the valve and allow it to flush for at least 15 minutes before taking the sample. For intermittently running wells purging should be carried out by pumping the well for 15 minutes and until the pH, specific conductance and temperature stabilize. In practice, stable sample chemistry is indicated when the purging parameter values remain within 5% over two successive samples taken at least 5 minutes apart.
2. All samples must be collected from the closest tap to the well head. All faucet screens/aerators are to be removed.
3. Reduce the flow to approximately 500 mL/minute.
4. The sample container should not touch the rim of the faucet.
5. Fill the sample container to almost full capacity (note: no headspace for VOC, TOX, and POX).
6. Quickly place the cap over the container and tighten securely.
7. Affix a sample label to the glass container. Wrap the container in bubble-wrap or equivalent to prevent breakage.
8. Place the wrapped container in a sealed plastic (ziplock-type) bag.
9. Place the sealed container(s) in an ice cooler on wet ice and complete the chain-of-custody form prior to transporting them to the laboratory.

4.2.3 *DRINKING WATER SUPPLY SYSTEM*

Water samples may be collected from industrial, public, and private water supply wells to support the site characterization of a facility. In most instances, details concerning well installation and development will be either unknown or fragmentary. Procedures for sample collection must be carefully followed and properly documented so that no questionable data is generated. Care must be taken to promote strong community relations with private, public, and industrial neighbors in the vicinity of the facility. Following properly documented field procedures will ensure that privately owned wells do not become damaged or contaminated through sampling activities.

The following procedures incorporate the necessary aspects of sampling quality control and shall be used each time a water supply well is sampled:

1. From existing well data or from an estimated well depth, calculate the maximum possible volume of water in the well casing.
2. Obtain a sample of groundwater for temperature, conductivity, and pH measurements. Record these measurements in the sampling logbook; and
3. Pump to discard at least 3 to 5 times the estimated volume of water in the well.

Untreated Water: Prior to taking samples, ensure that the water to be sampled is raw (untreated) water. Under no circumstances should treated water be taken for chemical analysis to define the levels of contaminants in the aquifer. If holding or pressure tanks are used in the water supply system, they should be bypassed to obtain good representative groundwater samples. Under no circumstances will the field technician pull a pump or insert a sampling device directly into a well unless specified and approved in the work plan or with the documented approval from the site manager.

1. All samples must be placed in appropriate containers. Samples for organic chemical analyses shall be placed in clean amber glass containers with Teflon-lined lids. Samples for volatile organics shall be placed in septum-sealed glass vials. Samples for inorganics shall be placed in clean polyethylene containers;

1. Add appropriate preservative and cap securely;

1. Label samples; and

1. Place containers in temperature controlled (4°C) coolers immediately after sampling and deliver to the laboratory as soon as possible.

Treated Water: Water treated with residual chlorine may interfere with VOC, BNA and bacterial analyses. Residual chlorine may be treated with the addition of sodium

thiosulfate ($Na_2S_2O_3$). Using a field chemical kit, test the water in a separate container for residual chlorine. If residual chlorine is present, collect the samples in appropriate container(s) using the required preservatives. Immediately add 0.008% $Na_2S_2O_3$ or 5 mg of $Na_2S_2O_3$ per liter water directly into the sample container(s). Affix a sample label, seal and transport in temperature controlled (4° C) coolers.

4.3 SURFACE WATER SAMPLING: The sampling of streams, rivers, ponds, sewers, lagoons and lakes requires great care in avoiding contamination and assuring the collection of representative samples. Surface water can be collected as grab samples or using a peristaltic pump. Prior to sample collection, impoundment characteristics (size, depth, flow) and the sampling site location must be recorded in the field logbook. Sampling should proceed from downstream locations to upstream locations so that disturbance related to sampling does not affect sampling quality. Additionally, if sediment samples are to be collected at the same locations as the water samples, the water samples must be collected first.

4.3.1 COLLECTING GRAB SAMPLES

The collection of grab samples involves dipping a beaker, dipper, or other transfer device into the surface of water to retrieve samples. The water sample can also be collected directly by dipping the collection container into the water and filling, removing, and capping it.

- If a transfer device is used, it must be constructed of inert material like Teflon or stainless steel. Use the transfer device to transfer liquid and liquid wastes from the surface water to the sample container. This method prevents unnecessary contamination that would result if the outer surface of the sample container were directly immersed in the water.
- Avoid using metal transfer devices for metals samples. Additionally, avoid using plastic devices sampling for organic compounds.
- Perform field chemistry on water.
- All samples must be placed in appropriate containers. Samples for organic chemical analyses shall be placed in clean amber glass containers with Teflon-lined lids. Samples for volatile organics shall be placed in septum-sealed glass vials. Samples for inorganics shall be placed in clean polyethylene containers;
- Add appropriate preservative and cap securely;
- Label samples; and
- Place containers in temperature controlled (4°C) coolers immediately after sampling; deliver coolers to the laboratory as soon as possible.

4.3.2 COLLECTING WITH A PERISTALTIC PUMP

To collect a sample with a peristaltic pump, use the following procedures:

1. Attach tubing to the peristaltic pump.
2. Lower the intake into surface water and begin water removal.
3. Perform water chemistry analysis.
4. Collect water samples in acceptable containers.
5. Fill the sample container, allowing the sample stream to flow gently with minimal entry turbulence.
6. Screw the cap onto the container tightly and shake the container if a preservative has been added.

7. Immediately, place the samples requiring refrigeration into temperature controlled coolers. **Keep all samples away from direct sunlight.**

4.4 SEDIMENT SAMPLING: The sampling of sediment/sludges in lakes, ponds, lagoons, streams, rivers, channels, sewers and leachate seeps is generally accomplished through the use of one of the following devices:

scoop or trowel	***Veihmeyer sampler***
sampler trier	***waste pile sampler***
bucket auger	***split spoon sampler***
soil coring device/silver bullet sampler	***ponar dredge***

Care must be taken to minimize disturbance and sample washing as it is retrieved through the water column above. While sediment samples are expected to be a solid matrix, the sampler should avoid placing the sampling device in the container and then decanting off the excess liquid. If samples are collected properly, any liquid that makes it into the container is representative of sediment conditions.

Sediment samples for organic and inorganic chemical analytes should be placed in clean, wide-mouth, amber-glass containers with Teflon-lined lids. Samples for volatile organics should be placed in containers appropriate for the analytical method. Portions of sediment may be placed in empty vials or vials containing extraction solvent. In other instances, sealed cores may be shipped to the laboratory for sub-sampling. The sampling method for volatiles in sediment will depend on the chemical analysis procedure and the nature of sediment. Place containers in a temperature controlled (4°C) coolers immediately after sampling and deliver coolers to the laboratory as soon as possible.

4.5 SOIL SAMPLING: All surface debris (leaves, grass, etc) must be cleared by a clean shovel or other appropriate implement for surface or shallow soil samples. Disturbed portions of soil samples collected by augers, split spoons or other samplers must be discarded, and must not be taken as part of the analytical sample. Grab samples will be mixed thoroughly (excluding those for VOCs) before being containerized. Samples for chemical analysis will not be collected from auger flights or cuttings from hollow stem auger flights. Samples used for geological or lithological determinations will not be used for trace contaminant analysis.

4.5.1 SURFACE SOIL SAMPLING

Standard Bucket Auger: A soil sample is taken by pushing and rotating the auger into the soil until the bucket is filled. The sample is then removed (with some difficulty) from the bucket by pushing or scraping with the appropriate, precleaned stainless steel tool. This auger is useful in obtaining unconsolidated soil. Addition of a sleeve will allow an undisturbed soil sample to be obtained. Either a butyl acrylate plastic steel sleeve (for inorganic samples) or stainless steel (for organic samples) may be used. A soil sample is obtained in a normal manner by pushing and rotating the auger into the soil. In this case it is the sleeve, which fills with soil. After auger retrieval, the sleeve is removed from the auger and capped. Sleeved samples for organics should have "caps" that are lined with Teflon. Organic samples must be taken from the central core of these liner samples.

4.5.2 DEEPER SUBSURFACE SOIL SAMPLING

A drill rig is needed if soil samples are taken from boreholes greater than 15 feet below land surface (BLS). There are a number of devices used in conjunction with the drill rig for retrieving the samples: shelby tubes, split spoon samplers, and standard core barrels.

Shelby Tube Samplers: After drilling to the required depth with an auger or rotary drill bit, a soil sample is obtained through the auger or directly in a borehole. The Shelby tube is pushed into the soil using the drill rig's hydraulic ram. When the tube is retrieved, the soil sample is taken from the center and away from the sides. The sample is transferred into the appropriate container using a stainless steel spoon handle or spatula.

Split Spoon Samplers: As with the Shelby tube, either the weight of the drill stem or a mechanical hammer is used to advance the sampler. A catcher device is inserted in the head ring to prevent loss of sample during recovery. After retrieving the split spoon, the soil sample can be withdrawn by unscrewing the bit and head rings and splitting the barrel. A clean stainless spatula is used to collect a sub-sample and to transfer the soil into an appropriate container.

Standard Cores: A standard core sampler is used when consolidated samples (such as limestone or dolomite) are to be sampled. Unscrewing the head ring and sliding the sample into the container can retrieve the sample core.

4.5.3 COMPOSITE SOIL SAMPLES

When a large site area has to be investigated, it is sometimes advantageous to composite soil samples and thus minimizes the number of samples to be analyzed. Soil aliquots (of identical size) to be composited should first be placed in a glass or stainless steel tray and thoroughly mixed with a cleaned stainless steel spoon before filling the sample container. The origin and size of each sub-sample must be documented in the field notebook with other sampling details. Clean the outside of the sample container, affix a label, seal, and complete the chain-of-custody forms.

To prevent the loss of volatiles, soil samples for VOC analyses must not be composited or homogenized. Sample containers for VOCs must be filled completely to eliminate headspace. This can be done by gently tamping the sample container with a glass rod.

4.6 HAZARDOUS WASTE/DRUM SAMPLING:

- If multiple aliquots are collected for a single sample, all sub-samples should be composited accordingly.
- Profile tubes are used to determine individual liquid phases in a stratified waste container.
- If waste stratification or phase separation is suspected, samples are collected by depth compositing of container contents to provide a representative sample. Container layers are documented and are taken into account when interpreting analytical results.

4.7 EQUIPMENT DECONTAMINATION PROCEDURES: Sufficiently cleaned equipment will be taken to the field so that an entire sampling operation is conducted without any need of field cleaning. Most of the field equipment is precleaned in-house prior to arrival on site. However, there are several instances where it is not possible to preclean equipment, such as large scale studies and specialized field equipment (such as portable augers, well drilling rigs, soil coring rigs). In these instances, field cleaning is necessary, and the following procedure is used:

1. Clean equipment with tap water and reagent grade detergent (Liquinox, Alconox or equivalent) using a brush if necessary to remove particulate matter and surface films.
2. Rinse thoroughly with tap water.
3. Rinse with 10% reagent grade nitric acid, but only if trace metals are to be sampled. The acid rinse should not be used on stainless steel equipment (bailers, augers, trowels, etc.). If sampling for nutrients, 10% reagent grade HCl should be used.
4. Rinse thoroughly with deionized water.
5. Rinse twice with pesticide grade or nanograde isopropanol.
6. Rinse thoroughly with analyte-free (organic-free or metal-free) water and allow to air dry as long as possible. If analyte free water is not available, do not rinse with deionized water or distilled water; just allow to air dry.

4.8 SAMPLE HANDLING

4.8.1 SAMPLE CONTAINERS/PRESERVATION/HOLDING TIMES

Standard sampling kits are used. The kits are prepared according to the type of analysis requested (***see Figure 4-3***). The types of containers used are presented on ***Table 4-1***. All sample kits are prepared by the sample custodian and made ready for walk-in clients, delivery by REIC courier, or shipment by bonded courier. All kit supplies are stored in a separate building from the laboratory to

avoid cross contamination. Unless specified, all sample containers used are precleaned commercially. They are purchased from commercial vendors as precleaned containers. Sample containers used at REIC laboratory are disposable, therefore, washing is not necessary before sample kits are prepared for clients or REIC field personnel. All sample kits are transported in coolers to the field. A Chain-of-Custody sheet is enclosed. The sample identification labels on the containers must always match those on the sample chain-of-custody sheets. Sample kits can be delivered by a REIC courier, picked up by the client, or shipped by bonded carrier (i.e. UPS, Federal Express). Clients are encouraged to transport samples to the laboratory as soon as possible so that holding times *(see Table 4-1)* will not be exceeded.

Although REIC Laboratory will give advice on sample shipping and packing, it is the sampler's ultimate responsibility to representatively sample, pack, and ship the samples to REIC Laboratory.

The types of preservatives used are provided in *Table 4-1*. Clients or REIC field personnel may receive sample containers pre-preserved. The laboratory will supply additional preservatives in suitable containers for sample preservation in the field. Special preservation protocol is as follows:

Volatiles: For volatiles, if residual chlorine is present, sodium thiosulfate is added to the sample vial first, the vial is then filled to at least half its volume with sample water, the appropriate amount of HCl is added, and finally filled with zero headspace. Sodium thiosulfate and HCl must not be mixed by themselves in the vial.

Cyanide: If cyanide will be sampled, test the sample with KI-starch paper. Add a few crystals of ascorbic acid and test until negative. Add an additional 0.6 grams of ascorbic acid for each liter of sample to remove the chlorine. Samples with visible particulates must be filtered. Keep this filter paper (#1). Sulfide may be tested with test papers (EM, Chemometrics) or kits (HACH). Tests may not detect sulfides in low enough concentrations to be useful. Remove sulfide by adding cadmium (or lead) nitrate or carbonate powder to the sample (filtrate) to precipitate the sulfides. Test for sulfides. Repeat the steps for sulfide detection until the test demonstrates no sulfides are present. Sulfides can now be filtered from the sample.

Reconstitute the sample by adding the precipitate collected on filter #1 back into the sample (filtrate). Add NaOH until sample pH>12 and cool to 4°C. The maximum holding time is 14 days. Equipment blanks must be handled the same way.

4.8.2 SAMPLE DISPATCH TO THE LABORATORY

- Field documentation will consist of (at a minimum): field notes, sample labels, and chain of custody forms (or sample transmittal forms).
- Samples will be packed such that they are segregated by site, sampling location or sample analysis type.
- VOC samples from different locations may be placed in the same coolers with materials (i.e. bubble wrapped and sealed in a ziplock-type bag) to avoid breakage.
- Shipping containers will be insulated (if cooling is required) and will be sealed with tape or locked to avoid tampering.
- Reusable refrigerant packs (not dry ice) or an H_2O ice bath will be used in cooling samples to 4°C.
- Packed samples will be delivered to the laboratory by the sampling team or via a common carrier.

4.8.3 FIELD REAGENTS AND WASTE HANDLING

All chemicals transported to the field will be stored in appropriate containers, labeled, and will be packed to avoid breakage. Chemicals will be segregated from sample containers so as to avoid accidental contamination. All reagents must be reagent grade or higher.

4.8.4 FIELD WASTE DISPOSAL

- All field generated wastes will be segregated and contained for proper disposal by a commercial contractor. Associated cost may be negotiated with clients in advance of the project initiation.
- All non-chlorinated solvents (isopropanol, hexane, and acetone) will be collected and returned to the laboratory to be disposed of or recycled by a commercial contractor.
- Acids and bases will be diluted or neutralized and can be flushed into a sanitary sewer or will be disposed of commercially.
- Contaminated purge waters will be contained and disposed of commercially or will be allowed to evaporate on an impermeable surface.
- Calibration standards for field meters will be diluted and flushed into the community treatment sewer.

Table 4-1 Required Containers, Preservation Techniques, and Holding Times

Measurement	Containers*	Preservation	Holding Time+
Bacterial Tests			
Coliform, Fecal & Total	***P,G***	Cool, 4°C 0.008% $Na_2S_2O_3$	**6 hours**
Fecal Streptococci	***P,G***	*Cool, 4°C 0.008% $Na_2S_2O_3$*	***6 hours***
Inorganic Tests			
Acidity	***P,G***	*Cool, 4°C*	***14 days*****
Alkalinity	***P,G***	*Cool, 4°C*	***14 days*****
Ammonia	***P,G***	*Cool, 4°C, H_2SO_4 to pH <2*	***28 days*****
Bicarbonate	***P,G***	*Cool, 4°C*	***14 days*****
BOD 5-Day	***P,G***	*Cool, 4°C*	***48 hours*****
Bromide	***P,G***	*None Required*	***28 days*****
Carbon, Organic (TOC)	***P,G***	*Cool, 4°C; H_2SO_4 to pH<2*	***28 days*****
COD	***P,G***	*Cool, 4°C; H_2SO_4 to pH<2*	***28 days*****
Chloride	***P,G***	*None Required*	***28 days*****
Chlorine, Residual	***P,G***	*None Required*	***Analyze Immediately*****
Conductance, Specific	***P,G***	*Cool, 4°C*	***28 days*****
Color	***P,G***	*Cool, 4°C*	***48 hours*****
Cyanide, Total & Amenable	***P,G***	*Cool, 4°C; NaOH to pH>12; 0.6 g ascorbic acid*	***14 days**, ++++***
Fluoride	***P***	*None Required*	***28 days*****
Formaldehyde	***G***	*Cool, 4°C*	***30 days*****
Hardness	***P,G***	*H_2SO_4 or HNO_3 to pH<2*	***6 months*****
Hydrogen Sulfide, Total	***P***	*Cool, 4°C; Add Zinc Acetate*	***28 days*****
Ignitability	***G***	*Cool, 4°C*	***7 days***
MBAS, (Surfactants)	***P,G***	*Cool, 4°C*	***48 hours*****
Nitrate-Nitrite	***P,G***	*Cool, 4°C H_2SO_4 to pH<2*	***28 days*****
Nitrate	***P,G***	*Cool, 4°C*	***48 hours*****

Note: Footnotes defined on page 4-22.

Table 4-1 Required Containers, Preservation Techniques, and Holding Times

Measurement	Containers*	Preservation	Holding Time+
Nitrite	***P,G***	Cool, 4°C	**48 hours****
Odor	***G***	Cool, 4°C	**Analyze Immediately****
Oil & Grease	***G***	Cool, 4°C; H_2SO_4 to pH<2	**28 days****
Kjeldahl Organic Nitrogen	***P,G***	Cool, 4°C; H_2SO_4 to pH<2	**28 days****
Orthophosphate	***P,G***	Filter Immediately, Cool, 4°C	**48 hours****
Oxygen, Dissolved	***G, Top& Bottle***	None Required	**Analyze Immediately****
Oxygen, Winkler	***Same***	Fix on site and store in dark	**8 hours****
pH	***P,G***	None Required	**Analyze Immediately****
Phenolic Materials	***G***	Cool, 4°C; H_2SO_4 to pH<2	**28 days****
Phosphorus, Total	***P,G***	Cool, 4°C; H_2SO_4 to pH<2	**28 days****
Phosphate, Total	***G***	Cool, 4°C; H_2SO_4 to pH<2 or Freeze	**28 days****
Phosphorus, Total Dissolved	***P,G***	Filter, Cool, 4°C; H_2SO_4 to pH<2	**24 hrs**
Phosphorus, Elemental	***G***	Cool, 4°C	**48 hrs**
Reactivity (CN&S)	***P,G***	Cool, 4°C	**14 days****
Residue, Total	***P,G***	Cool, 4°C	**7 days****
Residue, Filterable	***P,G***	Cool, 4°C	**7 days****
Residue, Nonfilterable	***P,G***	Cool, 4°C	**7 days****
Residue, Settleable	***P,G***	Cool, 4°C	**48 hours****
Residue, Volatile	***P,G***	Cool, 4°C	**7 days****
Sulfate	***P,G***	Cool, 4°C	**28 days****
Specific Gravity	***P,G***	Cool, 4°C	**Analyze Immediately****
Sulfide	***P,G***	Cool, 4°C; add Zinc Acetate & NaOH to pH>9	**7 days****
Sulfite	***P,G***	EDTA	**Analyze Immediately**
Turbidity	***P,G***	Cool, 4°C	**48 hours****

Note: Footnotes defined on page 4-22.

Table 4-1 Required Containers, Preservation Techniques, and Holding Times

Measurement	Containers*	Preservation	Holding Time+
Metals			
Chromium VI	***P,G***	*Cool, 4°C*	***24 hours*****
Mercury	***P,G***	*HNO_3 to pH<2*	***28 days*****
Metals, except Chromium VI and Mercury	***P,G***	*HNO_3 to pH<2*	***6 months***
Organic Tests (Semivolatiles)			
Chlorinated Hydrocarbons	***G Teflon Lined Cap***	*Cool, 4°C; 0.008% $Na_2S_2O_3$+++++*	***7 days to extraction 40 days after extraction***
Extractable Organic Halides (EOX)	***G Teflon Lined Cap***	*Cool, 4°C*	***28 days*****
Chlorinated Herbicides	***G Teflon Lined Cap***	*Cool, 4°C; 0.008% $Na_2S_2O_3$+++++*	***7 days to extraction 40 days after extraction***
PCB's	***G Teflon Lined Cap***	*Cool, 4°C; 0.008% $Na_2S_2O_3$+++++*	***7 days to extraction 40 days after extraction***
Pesticides	***G Teflon Lined Cap***	*Cool, 4°C; 0.008% $Na_2S_2O_3$+++++*	***7 days to extraction 40 days after extraction***
Phthalate Esters	***G Teflon Lined Cap***	*Cool, 4°C*	***7 days to extraction 40 days after extraction***
Phenols (Acid Extractables)	***G Teflon Lined Cap***	*Cool, 4°C +++++0.008% $Na_2S_2O_3$*	***14 days to extraction 40 days after extraction***
Polynuclear Aromatic Hydrocarbons (PAH)	***G Teflon Lined Cap***	*Cool, 4°C +++++0.008% $Na_2S_2O_3$ Store in Dark*	***7 days to extraction 40 days after extraction***
Total Organic Halogens (TOX)	***G Teflon Lined Cap***	*Cool 4°C; H_2SO_4 to pH<2*	***28 days*****
Organic Tests (Volatiles)			
Acrylonitrile & Acrolein	***G TeflonLined Cap***	*Cool, 4°C; 0.008% $Na_2S_2O_3$ +++++ Adjust pH to 4-5*	***14 days***

Note: Footnotes defined on page 4-22.

Table 4-1 Required Containers, Preservation Techniques, and Holding Times

Measurement	Containers*	Preservation	Holding Time+
BTEX	*G TeflonLined Cap*	Cool, 4°C; Hcl; pH<2; 0.008% $Na_2S_2O_3$+++++	**14 days**
Purgeable AromaticHydrocarbons	*G TeflonLined Cap*	Cool, 4°C; HCl to pH<2; 0.008% $Na_2S_2O_3$+++++	**14 days**
Purgeable Halocarbons	*G TeflonLined Cap*	Cool, 4°C; HCl to pH<2; 0.008% $Na_2S_2O_3$+++++	**14 days**
Trihalomethanes	*G TeflonLined Cap*	Cool, 4°C; HCl to pH<2; 0.008% $Na_2S_2O_3$+++++	**14 days**
Toxicity Testing			
Acute tests	*Cubitainers*	Cool, 4°C	**36 hours**
Chronic tests	*Cubitainers*	Cool, 4°C	**36 hours**
Renewal	*Cubitainers*	Cool, 4°C	**36 hours**
Screening	*Cubitainers*	Cool, 4°C	**36 hours**

BOD - Biochemical Oxygen Demand; PCB-Polychlorinated Biphenyl; HCl - Hydrochloric Acid
COD - Chemical Oxygen Demand; HNO_3 - Nitric acid (metals grade); NaOH -Sodium Hydroxide (ACS grade)
G - Glass; H_2SO_4 -Sulfuric acid (metals grade); $Na_2S_2O_3$ -Sodium Thiosulfate
P - Polyethylene; °C-Degrees Celsius; NS - None specified by EPA

* ***For nonvolatile organics, containers for soil and sediment samples are glass with Teflon-lined caps and for volatiles, containers are glass with Teflon-lined septum. Soil sample containers for organics are glass bottles with Teflon-lined caps, polyethylene (P), or glass (G).***

\+ ***Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the laboratory has data on file to show that the specific types of samples under study are stable for the longer time.***

** ***Holding times provided are for waters. EPA does not have holding times for these parameters in soil. These water holding times will be used as goals for those methods where a soil analysis is applicable.***

++ ***7/40 = 7 days until extraction; 40 days from extraction until analysis.***
14/40 = 14 days until extraction; 40 days from extraction until analysis.

*** ***Mercury in soil has a 6-month holding time (EPA, Contract Laboratory Program).***

+++++ ***Sample preservation should be performed immediately upon sample collection. The only preservation for soil samples is cooling at 4°C. For composite samples, each aliquot should be preserved at the time of collection. When use of an automatic sampler makes it impossible to preserve each aliquot, then samples may be preserved by maintaining at 4°C until compositing and sample splitting are completed. Only add sodium thiosulfate if the sample contains free or combined chlorine. A field test kit needs to be used for this determination. If free or combined chlorine is present, add sodium thiosulfate prior to the addition of HCl if HCl is required.***

**** ***These parameters are best analyzed in the field. In consideration of shipping limitations, when these analyses are requested of our laboratory for confirmation purposes, REIC policy is to analyze these constituents within 24 hours of receipt.***

++++ ***Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12. The ascorbic acid only needs to be added if an oxidizing agent such as chlorine is present.***

Section 5.0

Sample Custody & Integrity

5.0 Sample Custody and Integrity

Sample custody is a vital aspect of an environmental measurement program. Some environmental study programs generate data that may be used as evidence in a court of law. The samples must be traceable from the time of sample collection until the data is introduced as evidence in enforcement proceedings.

A sample is said to be in someone's custody if it meets the following criteria:

- It is in someone's physical possession,
- It is in one's view, after being in one's physical possession,
- It is in one's physical possession and then locked or sealed so that tampering will be evident, or
- It is kept in a secure area, restricted to authorized personnel only.

5.1 FIELD SAMPLING OPERATIONS: The chain-of-custody record is initiated at the time the sample containers are dispatched to the field sampling team. The field sampling team may be the client's or REIC's field sampling personnel. A formal sample custody record *(provided at the **end of this section**)* accompanies each set of containers. The form ensures that a system is made available by which sample information is logged from the point of sampling through each change of custody until the samples arrive at the laboratory. Although, the laboratory can give advice to the client on sample packaging and shipping procedures, it is the client's ultimate responsibility to provide proper and adequate documentation until the samples are relinquished. Then the samples are in physical possession of the one who accepts custody.

A Chain-of-Custody (COC) is used by the field team to record sample identification and the following information: sample description, collection date and time, sampling location, preservation, analyses required, samplers' names, comments concerning the samples, client name, and the signature of the person relinquishing the samples to the bonded carrier or REIC personnel. Errors in all field sampling documents are deleted with one line through the error, initialed and dated.

5.2 *LABORATORY OPERATIONS*

5.2.1 *RECEIVING SAMPLES*

Samples may be shipped to the laboratory or picked up by a REIC courier (when locality allows). In all cases, a REIC representative will sign, date, and record the time on appropriate custody forms as receiving the sample cooler. At the laboratory, the sample custodian will immediately initiate the following steps:

1. Check samples for breakage or leakage,
2. Check the temperature of the ice bath,
3. Verify the number of samples received and confirm that all container designations agree with information provided on the Chain-of-Custody.
4. Record any breakage of sample bottle seals, which may have occurred during transport to the laboratory.

The sample custodian notes the condition of the samples and coolers on the accompanying Chain-of-Custody forms and then proceeds to log the samples into a Laboratory Information Management System (LIMS). Upon finding any sample preservation or documentation discrepancies (broken sample containers, cooler damage) or any suspicious findings which might indicate that sample integrity has been compromised, the client is notified immediately and the matter is resolved before the samples are approved and actually accepted for analysis. A copy of the custody form is returned to the client with the sample analysis deliverable report and another copy is kept on project file at the laboratory. If the scope of the project should change after the samples have been received in the lab, this is documented on the Chain-of-Custody.

5.2.2 *BILL OF LADING*

A bill of lading (bus bill or airbill) documents receipt of the samples by the carrier. It is not possible for the carrier's representative to sign the custody form since it is sealed in the sample cooler. Bills of lading are kept on project files at REIC.

5.2.3 *TRACKING OF SAMPLES*

Proceeding with log-in, the sample custodian enters sample identifications (IDs) and other associated information such as: Lab sample IDs, sampling date, client IDs, etc., into a computerized sample

tracking system -- Laboratory Information Management System (LIMS). The tracking system consists of a customized program having the ability to search and locate individual samples in the laboratory.

All data within the computer system is copied (backed-up) on magnetic tape and secured at the end of each working day. Hard copies of sample tracking worksheets are maintained and copies placed in sample file folders along with Chain-of-Custody forms. These tracking documents, as well as the LIMS, help to coordinate the analyses required. Sample handling, preparation, and analysis are documented on tracking worksheets throughout their analysis period in the laboratory. The tracking worksheets include such information as the Lab sample IDs, clients IDs, storage, preservation, actions, sample date, extraction date, analysis date, etc.

5.3 *MAINTAINING SAMPLE INTEGRITY:* Upon receiving samples from the field, improper conditions for each sample will be documented on the chain of custody and will be reported to the Project Manager and the client. The Project Manager will then make a decision after consulting with Project Director and/or client Project Officer on whether to reject the sample.

REIC maintains walk-in environmental chambers, which are specific for various types of sample analyses. They are maintained in a manner such that internal contamination is minimized. The chambers are monitored and their environmental conditions are recorded continuously. Additionally, the chambers have both audible and electronic notification alarm systems to warn if ambient conditions drastically change due to chamber malfunctions.

Upon conclusion of the appropriate analysis, any additional sample materials are stored for a period of two weeks after formal notification of results being submitted to the client. At that time, the samples are disposed of (if requested) or returned to the client (at the client's expense). All sample disposal is carried out in an environmentally safe and regulatory, acceptable manner.

REIC

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CHAIN OF CUSTODY RECORD

NO. 113485

CLIENT: _____
ADDRESS: _____
CITY/STATE/ZIP: _____
BILL TO: _____
CITY/STATE/ZIP: _____
PURCHASE ORDER # _____
QUOTE # _____

CONTACT PERSON: _____
TELEPHONE #: _____
FAX #: _____
E-MAIL ADDRESS: _____
SITE ID & STATE: _____
PROJECT ID: _____
SAMPLER: _____

SAMPLE LOG AND ANALYSIS REQUEST

TURNAROUND TIME REQUIREMENTS
REGULAR: ___
*RUSH: ___ 5-Day
___ 3-Day
___ 2-Day
___ 1-Day
*Rush work needs prior Laboratory approval and will include surcharges

PRESERVATIVES
0 No Preservative
1 Hydrochloric Acid
2 Nitric Acid
3 Sulfuric Acid
4 Sodium Thiosulfate
5 Sodium Hydroxide
6 Zinc Acetate
7 EDTA

PRESERVATIVE CODES

NOTE PRESERVATIVES →

ANALYSIS REQUESTED & METHOD

SAMPLE ID	NO. & TYPE OF CONTAINERS	SAMPLING DATE / TIME	MATRIX	SAMPLE COMP / GRAB									COMMENTS

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Temperature Upon Arrival °C	☐ FAX Results	☐ Email Results	

Section 6.0

Calibration Procedures & Frequency

6.0 Calibration Procedures and Frequency

The quality assurance objective of instrument calibration is to ensure that the instrument employed is capable of producing acceptable quantitative data. Initial calibration is designed to indicate that the instrument is capable of acceptable performance at the beginning of the sample analysis sequence. Continuing calibration verification is necessary in order to demonstrate satisfactory instrument performance (calibration accuracy) over the duration of sample analysis.

6.1 FIELD INSTRUMENTS:

6.1.1 pH METER

Standardize the pH meter immediately before taking any measurements. The calibrating solutions must bracket the sample analyses - either pH 7.0 and pH 4.0 or pH 7.0 and pH 10.0. Use the following procedure to standardize the meter:

1. Place the probe in the pH 7.0 and adjust the knob to achieve a reading of 7.0.
2. Place the probe in the second solution (whether 4.0 or 10.0) and adjust the knob to achieve the reading of 4.0 or 10.0, accordingly.
3. Repeat those steps until adjustment is no longer needed.
4. Clean the probe with distilled water and clean tissue.

   Note: Store the probe in distilled water when not in use.

6.1.2 TEMPERATURE

No calibration is required in the field for the temperature probe. See laboratory thermometer comparison with the NIST certified thermometer ***(Section 6.3.8 "Temperature Monitoring").***

6.1.3 CONDUCTIVITY

Use a KCl solution to check the (K) constant daily. Maintain a record (log book) of each check. Clean the probe with distilled water and tissues. Measure conductivity of the sample in a Teflon or plastic bottle.

6.1.4 DISSOLVED OXYGEN (DO)

The oxygen meter to be used in the field will be calibrated in the laboratory. A record for calibration must be reviewed by the field technician before taking the instrument to the field.

6.2 STANDARD RECEIPT AND TRACEABILITY: Standards are prepared from pure or commercially available materials. Upon receipt, standards are dated and all information concerning these standards including LOT#, supplier, concentration, and purity is filed. If the standard has an expiration date, the date is circled in ink to ensure the analyst does not use expired standard. As the standards expire, each is disposed of in an environmentally safe manner. All other information concerning these chemicals can be obtained through the information in the purchase order book/REIC's inventory system and/or the supplier of chemicals as necessary.

Working standards are prepared either directly from the stock standard or an intermediate standard is prepared and the working standards are prepared from the intermediate standard. **A standards preparation log is maintained for each method.** The daily working standards are entered as prepared in a standards logbook. All stock and intermediate standards are prepared either in Class A volumetric glassware or serially diluted from standards prepared in Class A volumetric glassware.

6.3 LABORATORY INSTRUMENTS: The major instrumentation and calibration procedures are discussed below. This is only the general overview. Detailed calibration procedures and frequency are in each method and instrument manufacturer operation manual. All calibration materials are purchased (where possible) in a pure form and are diluted to working concentration levels using standard analytical techniques.

6.3.1 SPECTROPHOTOMETRIC, POTENTIOMETRIC, COLORIMETRIC, TURBIDIMETRIC, INFRARED (IR) AND ULTRAVIOLET ABSORPTION

This section applies to those inorganic and organic analyses that require the use of a standard calibration curve for calibration. The working calibration is generated by plotting the standard response for each standard versus the concentration of each standard. Quality control acceptance criteria for calibration of this group of instruments includes:

1. Constructing a 5 point calibration curve (4 standards and a blank) prior to any sample analysis,

as needed. Refer to the calibration instructions of the manufacturer and the specific calibration section of each EPA method. The correlation coefficient of the line must be ?0.995. Failure to meet this criteria will necessitate reanalysis of the standards.

2. Monitoring of the instrument's consistency response is demonstrated through the analysis of a midlevel standard or Continuing Calibration Verification (CCV) after the analysis of ten (10) samples. The response of the CCV must be within ±20 percent of the true value. Failure to meet this criteria will necessitate reanalysis of all samples analyzed since the last acceptable CCV.
3. Demonstrating system cleanliness through the analysis of a method reagent blank prior to sample analysis.
4. Maintaining sample response within the response limits of the standards.

6.3.2 pH AND ION SPECIFIC ANALYZERS

Quality control acceptance criteria for the calibration of this group of instruments includes:

1. Constructing a three (3) point (2 point for pH) calibration curve prior to the analysis of any sample(s).
2. Verifying instrument's consistency response through the periodic analysis (after the analysis of every 10 samples) of standards.
3. Demonstrating system cleanliness through the analysis of a method reagent blank prior to sample analysis.
4. Maintaining sample response within the limits of the standards' response.

The pH meter is calibrated with known buffer via the pH closest to the expected sample pH. A second buffer (4, 7, or 10) is used to verify that the first measurement (buffer) was correct.

6.3.3 TRACE METALS AND CYANIDE ANALYSIS CALIBRATION

a. Atomic Absorption Analysis

Volumetric dilutions are made from stock solutions to obtain intermediate standard (10, 100 and 1.0 ppm) solutions. These intermediate standards may be used directly as working standard solutions for flame analysis. However, for more sensitive graphite furnace and hydride analyses, volumetric dilutions must be prepared from the 1.0 and 10 ppm standard solutions to generate working standards. The working standard solutions must be prepared daily. The acceptance criteria for calibration of the AA is as follows:

1. The instrument must be calibrated daily and each time the instrument is set up. A blank and at

least three standards must be used in establishing the calibration curve. One of the standards must be at the method reporting limit (or detection limit).

2. The correlation coefficient of the line must be ?0.995. Failure to meet this criteria will necessitate reanalysis of the standards.
3. Instrument consistency is monitored through the analysis of a midlevel standard (CCV) and the calibration blank after the analysis of ten (10) samples. The response of the CCV must be within ±10 percent of the true value. Failure to meet this criteria will necessitate reanalysis of all samples analyzed since the last acceptable CCV.
4. System cleanliness is demonstrated through the analysis of a reagent blank prior to sample analysis.
5. The sample response must be maintained within the limits of the response of the standards.

b. Mercury Analysis

1. The instrument must be calibrated daily and each time the instrument is set up. A blank and at least three standards must be used in establishing the calibration curve.
2. The correlation coefficient should be ?0.995.
3. Continuing calibration verification (CCV) standards are analyzed at a minimum of every 10 samples to document consistent instrument response. The CCV result must be within ±10% of the true value.

c. Cyanide Analysis

1. The instrument must be calibrated daily and each time the instrument is set up. A blank and at least three standards must be used in establishing the calibration curve.
2. The correlation coefficient for the photometric calibration should be ?0.995.
3. Initial calibration verification (ICV) and Continuing calibration verification (CCV) standards are analyzed at a minimum of every 10 samples to document consistent instrument response. The results of ICV and CCVs for each element in the solution must be within 15% of their respective true values.

d. Inductively Coupled Argon Plasma (ICP-AES)

Multi-element calibration standards are prepared as needed. The analyte concentrations in the standards are verified daily by observing changes in emission intensity and by analyzing known independent check standards.

1. The instrument is calibrated daily and each time it is set up. A blank and three standards are used in establishing the analytical calibration curve.

2. Continuing calibration verification standard and a continuing calibration blank are analyzed at a minimum of every 10 samples to document consistent instrument response. The results of CCVs for each element in the CCV solution must be within 10% of their respective true values.
3. A laboratory control matrix spike (LCS) serves as a monitor of the overall performance of all steps in the analysis, including the sample preparation. All aqueous LCS results must fall within 20% or less of the true value.

e. Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)

Multi-element calibration standards are prepared as needed. Analyte concentrations in the standards are verified daily by analyzing known independent check standards.

1. The instrument is calibrated daily and during each set up. A blank and at least two standards (generally 3) are used in establishing the analytical calibration curves.
2. A continuing calibration verification (CCV) solution and a continuing calibration blank are analyzed after every 10 samples to document consistent instrument response. The results of the CCV's for each element must be within 10% of their respective true values.
3. A laboratory control matrix spike (LCS) serves as a monitor of the overall performance of all steps in the analysis, including the sample preparation. All aqueous LCS results must fall within 20% or less of the true value.
4. Mass and detector calibrations are performed on a weekly basis. Tuning of the instrument is performed daily.

6.3.4 TUNING AND GC/MS MASS CALIBRATION

1. Refer to calibration instructions of the manufacturer and the specific calibration section of each EPA method for analysis of volatiles and semivolatiles.

2. A tune must be performed every 12 hours during analysis of samples. For BNA analysis the instrument shall be tuned to DFTPP. For VOA analysis the instrument is tuned to BFB. Tuning is designed to assure that instrument response meets specifications. See ***Table 6-1*** for mass intensity specifications for DFTPP and BFB.
3. No data may be collected prior to the initial tune. For VOA analyses, the BFB tune must be performed before calibration. For BNA analysis, the DFTPP tune and the initial or continuing calibration may be performed simultaneously.

4. Generate a five (5) point initial calibration for all method compounds. The relative response factor (RRF) will be calculated for each compound. The percent relative deviation (%RSD) will be calculated for each calibration check compound (CCC).
5. For all CCCs (VOA and BNA), the RSD must be less than or equal to 30 percent according to EPA-SW-846 or 35 percent according to EPA method 625.
6. A midlevel standard from the initial calibration standards is used in daily analysis. The difference between the average RRF of the CCCs in the daily calibration and initial calibration standards must be less than or equal to 20 percent (EPA 624, SW846: 8260B, and SW-846: 8270C) or 25 percent (EPA 625)).

6.3.5 *GC/HPLC ANALYSES*

1. Generate a 5 point calibration curve for all analyzed compounds monthly or prior to any sample analysis, as needed. Refer to the calibration instructions of the manufacturer and the specific calibration section of each EPA method.
2. Analyze the instruments consistency response through the analysis of a standard after the analysis of every ten (10) samples.
3. Demonstrate system cleanliness through the analysis of a reagent blank prior to sample analysis.
4. Maintain sample response within the limits of the response of the standards.

6.3.6 *GRAVIMETRIC METHODS CALIBRATION*

A set of Class S certified weights is used to check the calibration daily. The analytical balance is checked with at least one weight. The weight selected is to reflect the routine use of the balance. The check is performed by the first analyst to use the balance during the day. Results are recorded in the balance calibration logbook. The full set of Class S weights is used to check calibration on a monthly basis. All analytical balances are re-certified on an annual basis.

6.3.7 *TITRIMETRIC METHODS CALIBRATION*

Primary standard reference materials are purchased through a supplier. All purchased titrants and back titrants must be standardized and certified by the supplier. QC check standards of the parameter of interest will be prepared and analyzed to verify standardization and the analyst ability to discern the end point.

6.3.8 TEMPERATURE MONITORING

Temperatures for refrigerators, ovens and incubators are measured on a daily basis and recorded in appropriate temperature logbooks. Dedicated thermometers are checked annually against the NIST certified thermometer and documented. Walk in coolers and study chambers are fitted with wheel chart recording thermometers that monitor and record temperatures continuously on a 24 hour basis. These recording thermometers have both audible and electronic alarm systems. The temperature recordings are verified annually against the NIST certified thermometer. Equipment with out-of-control temperature findings will be adjusted to correct the temperature and it will be monitored more frequently until the temperature is in-control and steady.

6.3.9 DOHRMAN INSTRUMENT

TOX Analysis: Daily, prior to sample analysis, the instrument is checked by analyzing a standard in duplicate and one blank. Then three to seven nitrate-wash blanks are analyzed to establish the repeatability of the method background. The net response to the calibration standard must be within 3 percent of the calibration standard value. Verify the calibration standard by analyzing a standard after each group of eight sample determinations.

EOX Analysis: Daily, prior to sample analysis, analyze a standard reference material to obtain a single point calibration. Measure three to five ethyl acetate blanks to establish the method background. Both low level and high level standards are then analyzed to verify the linearity of the calibration curve.

TOC Analysis: Define an operating calibration curve daily prior to sample analysis by measuring a reagent blank and at least three organic carbon standards. Compare results to the manufacturer's suggested acceptance criteria. Analyze a reagent blank and a standard after every 15 to 20 sample measurements. Each check must be within the manufacturer's acceptance criteria.

6.3.10 ION CHROMATOGRAPH

1. Generate a 4-point calibration curve for all analyzed ions each time the eluant is changed, to be used as a reference standard curve. Refer to calibration instructions of the manufacturer and the specific calibration section of the EPA methods.

2. Analyze a set of 4 standards, identical to those used in the generation of the reference curve, daily to calibrate the instrument for the various methods performed.
3. Demonstrate the instrument's consistency response through the analysis of a standard after every ten (10) samples analyzed.
4. Demonstrate system cleanliness through the analysis of a deionized water blank prior to sample analysis.
5. Maintain sample response within the limits of the response of the standards.

6.3.11 ADIABATIC CALORIMETER

A benzoic acid pellet is analyzed prior to any analysis to ensure correct operation of the calorimeter. Each time the calorimeter is repaired or moved, an initial demonstration of performance consisting of analysis of ten (10) benzoic acid pellets is needed. The value of the pellet must fall within the acceptable range of 2400 cal/g ± 10 cal/g. Should the value fall out of the acceptable limits, another pellet is analyzed. If the value is still unacceptable, troubleshooting and servicing may be needed.

Table 6-1 Tune Criteria for Volatile and Semivolatile GC/MS Analyses

BFB Key Ion Abundance Criteria[a]	
Mass	**Ion Abundance Criteria**
50	*15 - 40% of mass 95*
75	*30 -60% of mass 95*
95	***base peak, 100% relative abundance***
96	***5 to 9% of mass 95***
173	***< 2% of mass 174***
174	*> 50% of mass 95*
175	***5 to 9% of mass 174***
176	*> 95% but < 101% of mass 174*
177	*5 - 9% of mass 176*

[a]Test Methods for Evaluating Solid Waste, Final Updates III. Revision 4, December 1996. Method 8260B, p.36.

DFTPP Key Ion Abundance Criteria[b]	
Mass	**Ion Abundance Criteria**
51	*30 - 60% of mass 198*
68	*< 2% of mass 69*
70	*< 2% of mass 69*
127	*40 - 60% of mass 198*
197	*< 1% of mass 198*
198	*base peak, 100% relative abundance*
199	*5 - 9% of mass 198*
275	*10 - 30% of mass 198*
365	*> 1% of mass 198*
441	*present but < mass 443*
442	*> 40% of mass 198*
443	*17 - 23% of mass 442*

[a]Test Methods for Evaluating Solid Waste, Final Updates III. Revision 4, December 1996. Method 8270C, p.36.

Section 7.0

Analytical Procedures

7.0 Analytical Procedures

7.1 FIELD ANALYTICAL PROCEDURES: Conductivity, salinity, pH, dissolved oxygen, and temperature are the most common field parameters. These parameters are measured in the field according to EPA methods *(see Section 3.0)* and internal REIC SOPs.

7.2 LABORATORY ANALYTICAL PROCEDURES: The analytical procedures used are listed in Section 3.0. Analyses of samples will be performed in accordance with protocols and QA procedures established by the EPA.

7.2.1 SOURCES FOR DRINKING WATER METHODS

a. Title 40 of the *"Code of Federal Regulations"* (40 CFR), Parts 141 and 143 National Primary and Secondary Drinking Water Regulations; Sampling, Monitoring, and Analytical Requirements; monthly subscription to "BNA's Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.

b. *"Methods for the Determination of Organic Compounds in Drinking Water"*, EPA/600/4-88/039, Dec. 1988; Revised July 1991; appended with "Supplement I", EPA/600/4-90/020, July 1990; and "Supplement II", EPA/600/R-92/129, Aug. 1992; U.S. EPA.

c. *"Manual for the Certification of Laboratories Analyzing Drinking Water,* Third Edition", EPA/570/9-90/008; amended by "Change 1", EPA/570/9- 90/008A; and "Change 2", EPA/814/B-92/002, Sept. 1992; U.S. EPA.

d. *"Methods for Chemical Analysis of Water and Wastes"*, EPA/600/4-79/020; March 1983, U.S. EPA.

e. *"Annual Book of ASTM Standards"*, Vols. 11.01 and 11.02; reprinted annually; American Society for Testing and Materials, Philadelphia, PA.

f. *"18th Edition of Standard Methods for the Examination of Water and Wastewater"*, 1992; and the *"18th. Edition Supplement"*, 1994; American Public Health Association, Washington, DC.

g. *"Methods for the Determination of Metals in Environmental Samples"*, EPA/600/4-

91/010, June 1991; appended with "Supplement I", EPA/600/R- 94/111, May 1994; U.S. EPA.

h. *"Methods for the Determination of Inorganic Substances in Environmental Samples"*, EPA/600/R-93/100; Aug. 1993, U.S. EPA.

i. *"Technical Notes on Drinking Water Methods"*, EPA/600/R-94/173; Oct. 1994, U.S. EPA.

j. *"Microbiological Methods for Monitoring the Environment, Water and Waste"*, EPA/600/8-78/017, Dec. 1978; U.S. EPA.

7.2.2 SOURCES FOR WASTEWATER (NPDES) EFFLUENT METHODS

a. *"Guidelines Establishing Test Procedures for the Analysis of Pollutants"; Title 40 "Code of Federal Regulations"* (40 CFR), Part 136; Tables IA, IB, IC, ID, and IE; and Table II; monthly subscription to "BNA's Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.

b. *"Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, Fourth Edition", EPA/600/4-90/027F, 1993; U.S. EPA.

c. *"Official Methods of Analysis of the AOAC, 15th Edition"*, 1990; Association of Official Analytical Chemists, Arlington, VA.

d. *"Appendix C to Part 136 - Inductively Coupled Plasma / Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes, Method 200.7"*; Title 40 CFR 136; "BNA's Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.

e. *"Methods for Chemical Analysis of Water and Wastes"*, EPA/600/4-79/020; March 1983, U.S. EPA.

f. *"Standard Methods for the Examination of Water and Wastewater"*; 18th Edition, 1992; 15th Edition and it's Supplement, 1981; and the 14th Edition, 1976; American Public Health Association, Washington, DC.

g. *"Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater"*, Sept. 1978; U.S. EPA.

h. *"Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater"*; Title 40 CFR 136; "BNA's Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.

i. *"Annual Book of ASTM Standards"*, Vols. 11.01 and 11.02; reprinted annually; American Society for Testing and Materials, Philadelphia, PA.

j. *"Microbiological Methods for Monitoring the Environment, Water and Waste"*, EPA/600/8-78/017, Dec. 1978; U.S. EPA.

7.2.3 SOURCES FOR SURFACE WATER AND GROUNDWATER METHODS

1. *"Test Methods for Evaluating Solid Waste, Physical / Chemical Methods*, Third Edition, SW-846", Nov. 1986; revised by "Revision I", Dec. 1987; amended by "Update I", July 1992; "Update IIA", Aug. 1993; and "Update IIB", Sept. 1994; "Update III", December 1996. U.S. EPA.
2. *"US EPA Contract Laboratory Program, Statement of Work for Inorganic Analysis"*; Document No. ILM 04.0, 1993.
3. *"US EPA Contract Laboratory Program, Statement of Work for Organic Analysis"*;

Document Nos. OLM 03.0 and Revision OLM 03.1, Aug. 1994.

4. *"Superfund Analytical Methods for Low Concentration in Water for Inorganics Analysis"*; Oct. 1991, U.S. EPA.
5. *"Superfund Analytical Methods for Low Concentration in Water for Organics Analysis"*; Oct. 1992, U.S. EPA.

7.2.4 SOURCES FOR SOLIDS, SEDIMENTS, AND SOILS METHODS

1. *"Test Methods for Evaluating Solid Waste, Physical / Chemical Methods, Third Edition, SW-846"*, Nov. 1986; revised by "Revision I", Dec. 1987; Amended by "Update I", July 1992; "Update II", Aug. 1993; and "Update IIA", Sept. 1994; and Update IIB, Jan. 1995; "Update III", Revised December 1996. U.S. EPA.
2. *"US EPA Contract Laboratory Program, Statement of Work for Inorganic Analysis"*; Document No. ILM 03.0, 1992 and ILM03.0, 1992; U.S. EPA.
3. *"US EPA Contract Laboratory Program, Statement of Work for Organic Analysis"*; Document Nos. OLM 03.0 and Revision OLM 03.1, Aug. 1994.
4. *ASTM Methods from "Annual Book of ASTM Standards", reprinted annually;* American Society for Testing and Materials, Philadelphia, PA.
5. *"Official Methods of Analysis of the AOAC, 15th Edition"*, 1990; Association of Official Analytical Chemists, Arlington, VA.

7.2.5 SEWAGE SLUDGE (RESIDUAL) TESTS FOR LAND USE/DISPOSAL

1. Title 40, Part 503 of the *"Code of Federal Regulations"* (40 CFR 503), for EPA Standards for the Use or Disposal of Sewage Sludge; subscription to BNA's Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.
2. *"Publicly Owned Treatment Works (POTW) Sludge Sampling and Analysis Guidance Document"*, Office of Water Permits Division; 1989; U.S. EPA.
3. *"Test Methods for Evaluating Solid Waste, Physical / Chemical Methods, Third Edition, SW-846"*, Nov. 1986; revised by "Revision I", Dec. 1987; Amended by "Update I", July 1992; "Update II", Aug. 1993; and "Update IIA", Sept. 1994; and Update IIB, Jan. 1995; "Update III", Revised, December 1996. U.S. EPA.
4. *"Standard Methods for the Examination of Water and Wastewater"*; 18th Edition, 1992; American Public Health Association, Washington, DC.
5. *"Methods for Chemical Analysis of Water and Wastes"*, EPA/600/4-79/020; March 1983, U.S. EPA.

7.2.6 *SOLID AND HAZARDOUS WASTE CHARACTERIZATION TESTS*

1. *"Test Methods for Evaluating Solid Waste, Physical / Chemical Methods, Third Edition, SW-846"*, Nov. 1986; revised by "Revision I", Dec. 1987; Amended by "Update I", July 1992; "Update II", Aug. 1993; and "Update IIA", Sept. 1994; and Update IIB, Jan. 1995; "Update III", June 1996, Revised December 1996. U.S. EPA.
2. *ASTM Methods from "Annual Book of ASTM Standards"*, reprinted annually; American Society for Testing and Materials, Philadelphia, PA.
3. *"US EPA Contract Laboratory Program, Statement of Work for Inorganic Analysis"*; Document No. ILM 03.0, 1992.
4. *"US EPA Contract Laboratory Program, Statement of Work for Organic Analysis"*; Document Nos. OLM 03.0 and Revision OLM 03.1, Aug. 1994.

7.2.7 *BIOLOGICAL METHODS*

7.2.7.1 *Microbiological:*

1. *Title 40, Part 141, Subpart C of the "Code of Federal Regulations"* (40 CFR 141.21), for Drinking Water Monitoring and Analytical Requirements, Coliform Sampling; monthly subscription to "BNA's Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.
2. *Title 40, Part 136, Table IA, of the "Code of Federal Regulations"* (40 CFR 136.3) for the List of Approved Biological Test Procedures; monthly subscription to "BNA's Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.
3. *"Microbiological Methods for Monitoring the Environment, Water and Waste"*, EPA/600/8-78/017, Dec. 1978; U.S. EPA.

7.2.7.2 *Toxicity Characterization (Bioassay):*

1. *"Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, Fourth Edition", EPA/600/4-90/027F, 1993; U.S. EPA.
2. *"Short-Term Methods for Estimating the Chronic Toxicity of Effluent and Receiving*

Waters to Freshwater Organisms, 2nd Edition", EPA/600/4-89/001, 1989; U.S. EPA.

3. *"Short-Term Methods for Estimating the Chronic Toxicity of Effluent and Receiving Waters to Marine and Estuarine Organisms"*, EPA/600/4-87/028, 1988; U.S. EPA.

7.2.8 MODIFICATIONS TO APPROVED METHODS

If a modified procedure is proposed, the client will be notified for and asked to absorb the cost incurred for new method development or modification for the approved EPA methods. A complete method description and associated quality control parameters (precision, accuracy, method detection limits/reporting limits) will be provided prior to or simultaneously with the sample analysis.

7.3 LABORATORY GLASSWARE CLEANING: Surface residues and soils in the glassware are removed and disposed of in the appropriate waste containers and dirty glassware is drained of solvents prior to submitting for cleaning. All laboratory glassware (volumetric flasks, separatory funnels, extraction tubes, beakers, graduated cylinders, and others) is cleaned according to the analysis/parameter group listed in ***Table 7.1***. Cleaned glassware is returned to the proper storage cabinets in each laboratory.

Table 7-1. Laboratory Glassware Cleaning Procedures

Glassware Type	Cleaning Procedure*
Bioassay	1-3, 5, 4, 16, 12
COD/BOD	1-3, 15, 4, 16, 12
Extractable Organics (Pesticides & Herbicides)	1-4, 5 or 6, 12, 13
Microbiology	1-4, 14
Nutrients/Classics	1-4, 8, 4
Petroleum Hydrocarbons	1-4, 7, 13
Residues	1-4, 10
Trace Metals	1-4, 9, 4, 16, 12
Volatile Organics	1-4, 8, 13

1. Remove all labeling from bottles and glassware.
2. Wash with hot tap water and Alconox (Liquinox). Scrub insides of glassware and any fittings with a brush.
3. Rinse thoroughly with hot tap water (3 times).
4. Rinse thoroughly with deionized water.
5. Rinse thoroughly with pesticide grade methylene chloride.
6. Rinse thoroughly with pesticide grade hexane.
7. Rinse thoroughly with freon.
8. Rinse with or soak in 1:1 HCl.
9. Soak in 1 part trace metals grade HNO_3
10. Bake at 180°C for 3-4 hours (as per method).
11. After use, rinse with last solvent used.
12. Store inverted or capped with suitable material or suitable container stopper.
13. Rinse with solvent used in the analysis prior to use.
14. Autoclave at 250°C for 30 minutes.
15. Nochromix rinse.
16. Air dry.

Cleaning Procedures are followed in order specified.

7.4 LABORATORY REAGENTS:

1. Spectroscopic grade - stored in a cabinet designated for general storage.
2. ACS grade - stored in a secure cabinet with limited access.
3. Laboratory grade - stored in cabinets designated for storage of reactive chemicals. Each chemical is separated from any other chemical with which it can react dangerously.
4. Industrial Grade - stored in the **flammables only** cabinets.
5. Indicator - stored in desiccator.
6. Purity certified by supplier - stored in the non-flammable cabinets.
7. Certified & Tested to meet standard methods 16th edition standards - stored in vented cabinets for acid storage. Each acid stored separately.
8. Purified - stored in the **flammable solvents only** cabinets.

All chemicals are dated and initialed upon arrival at the laboratory. Chemicals are dated and initialed when opened.

7.5 LABORATORY WASTE DISPOSAL: Waste materials generated in the laboratory are disposed of promptly and properly. The following procedures are employed in the disposal of laboratory wastes:

7.5.1 Liquid Wastes

1. In general, no chemical wastes may be disposed of in the sink.
2. Only certain dilute and neutralized acid wastes can be disposed of in the sink.
3. Disposal of Standards and Solutions - as standards and solutions are made, the solvents, constituents, date, and initial must be placed on the container. This information must be on the containers before it is offered for disposal. Standards containing any amount of organic solvents must not be poured into the sink. Aqueous standards containing organic or inorganic (metals, etc.) compounds must be stored in the appropriate waste container/drum and disposed of in accordance with an approved disposal company.
4. Disposal of solvent wastes - All solvents must be disposed of into the appropriate container located in the extractions laboratory. The waste container will be emptied by designated waste disposal personnel only.
5. Waste FREON and chloroform are segregated from other solvent wastes for recycling purposes. Each is disposed of in glass bottles then into 5-gallon containers with appropriate label on the outside. Waste from TCLP extractions is collected and stored in an acceptable manner.

7.5.2 SOLID WASTES

1. Solvent saturated solids and soil samples are collected and stored in an acceptable manner for disposal.
2. Vials are disposed of in the incineration glass container.
3. Unmarked containers or unknowns cannot be disposed of until they are identified.

7.5.3 SAMPLE WASTE RETURN POLICY

In general, samples are returned to the client two weeks after a final report has been submitted.

7.5.4 SAMPLE WASTES DISPOSAL

The following procedures are used to dispose of excess samples that have completed all necessary testing:

1. Samples will be disposed of in two weeks after the final report has been submitted to the client - unless longer time is authorized by the Laboratory Director, Laboratory Manager, or the Project Manager.
2. Prior to disposal, a sample disposal list will be generated by the appropriate waste disposal personnel. This list will be maintained in a logbook.
3. Non-hazardous soil samples will be bulked into a drum for offsite disposal.
4. Non-hazardous water samples will be disposed of by neutralization where necessary and then processed through the local waste water treatment system.
5. Empty sample containers should be disposed of (after crushed) in a dumpster. Appropriate protective equipment must be worn (safety glasses, gloves, etc.) when crushing empty sample containers.
6. If samples are deemed hazardous they will be returned to the client.

Section 8.0

Data Reduction, Validation, & Reporting

8.0 Data Reduction, Validation, and Reporting

8.1 ANALYTICAL DATA REDUCTION: Data transfer and reduction are essential functions in summarizing information from field and laboratory measurements. It is essential that data reduction processes are performed accurately, and that accepted statistical techniques are used. Analysts will be responsible for calculating final data and QC data from raw data recorded in the field logbooks, laboratory bench sheets, chart recordings, instrument printouts, and computer printouts.

8.1.1 FIELD DATA

Data obtained from field instruments such as pH meters, salinity and conductivity meters, and dissolved oxygen meters, is read directly from the instrument in appropriate units. Such instruments are used after calibration has been performed according to the owner's operation manual or REIC's field standard operating procedures. Data is recorded by the field analyst into the field logbooks. Data validation in the field involves making several readings to evaluate reproducibility of a measurement. The field team leader or any other member of the field team will review the field notes daily. The initials of the reviewer and date of the review will be entered on each page of the field logbook. The field data is sent to the laboratory in the field logbooks and is reported to the client in the hard copy laboratory reports.

8.1.2 LABORATORY DATA

Data that is obtained directly from instruments such as conductivity meters, pH meters, and the total carbon analyzer is entered manually onto bench worksheets. Some procedures, however, require reading graduation marks on glassware, observing color changes, and performing tests in replicates.

Many methods use instrumental methods of analysis, in which the instrument is connected to a microprocessor or have microprocessor data systems as integral parts of the instrument. In such cases the calculations are internally performed once the appropriate calibration standards are entered into the instrument. The instrument analyses are calibrated in appropriate units. During the analyses, instruments coupled to computer controlled systems, convert signals to raw digital data, capture raw data, integrate, generate calibration and response factors, calculate and produce results. Results are expressed in units such as: micrograms per liter (ug/L), milligrams per liter (mg/L), milligrams per kilogram (mg/kg), etc.

All data generated from spectrophotometric methods of analysis is computed according to Beer's law to produce a calibration curve based on the level of concentration of standards run during the analysis. The analyst ensures that the standards bracket the sample response, and that all data is generated from the linear portions of the calibration curve.

When the analysts record data onto loose bench worksheets, or into the LIMS, they verify that all data entries and date sequences are correct. Drawing a line through the incorrect entry, followed by initials, makes correction of any worksheet error. All loose sheets are kept in bound books. Periodically the sheets are removed and filed. Bound notebooks are also used for chronological sequence of data insertion. The pages are numbered and a table of contents is entered for referencing. All bench sheets, ring-binder books, and bound notebooks (logbooks) never leave the laboratory. -They serve as a source of information for data transfer to appropriate report forms. LIMS files are backed-up daily and stored in case hardware failure is experienced within the computer system.

8.2 DATA VALIDATION:

8.2.1 VALIDATION BY THE ANALYST

Data validation begins with the bench analyst. The analyst will check the entry of input data and calculations against the raw data. The initials of the analyst as a reviewer and date are entered on all data batches reviewed. The analyst must also review Chain-of-Custody sheets, extraction, digestion and instrument logs.

8.2.2 VALIDATION BY THE PROJECT CHEMIST

The ***Project Chemist*** is responsible for the review of project data before reporting. These responsibilities include making sure that reported final data is correct and has been reviewed against the raw data. The ***Project Chemist*** will compare final data against previous values for any obvious errors in reported values and to ensure that all the supporting data including QC results is present.

8.2.3 VALIDATION BY THE QUALITY ASSURANCE OFFICER

The QA Officer will review at least 2 data batches generated per month. The requirements to be checked in data validation are provided below as inorganic and organic data review parameters.

INORGANIC DATA CHECKS
Sample Chain of Custody (COC)
Extraction and analysis sample holding times
Calibration:
Initial calibration
Initial calibration verification
Continuing calibration verification
Blanks
ICP interference check samples
Laboratory control matrix spike
Duplicate sample
Matrix spike sample
Furnace atomic absorption QC
ICP serial dilution
Field duplicates
Equipment blanks

ORGANIC DATA CHECKS
Sample Chain of Custody (COC)
Extraction & analysis sample holding times
Initial calibration
Continuing calibration verification
Blanks
Surrogate recoveries
Duplicate sample
Matrix spike/Matrix spike duplicate
Internal standard performance
Compound identification
Compound quantitation & Reporting limits
System performance
Field duplicates
Equipment blanks
Chromatogram retention times
Mass spectrometer tuning criteria compliance

8.3 DATA REPORTING: Reports include all pertinent information as to the origin of samples, client and sample identification, method of analysis, internal lab identification, minimum quantification level, appropriate delimiting footnotes, quality control data, date of analysis, and the analyst's name and signature. Raw data is not normally provided in the formal report, but can be included if the client desires. Reports are proofed by the Project Chemist, then in turn by the Laboratory Manager (Inorganic and/or Organic), then finally by the Laboratory Directors who prepares a cover letter explaining any details needing additional comment. Upon completion and data verification, the report is sent to the client and mailing date reported in the LIMS.

8.4 DATA ARCHIVING: Copies of Chain-of-Custody forms, sample tracking worksheets, raw data, QC/QA materials, formal reports, and laboratory performance reports are kept on file by the laboratory for a minimum of three years. These files are available to the client or their approved representative(s) for review at any reasonable time within this period. All bench logbooks, instrument maintenance logs, and supplies record books are dated in consecutive order, filed, and kept indefinitely.

Section 9.0

Internal QC Checks

9.0 Internal Quality Control Checks

Internal quality control (QC) checks are those procedures used during all phases of the project that are designed to control the individual processes involved in data generating activities. The QA objectives of a given project and the anticipated uses of data determine the type of QC checks needed. The QC checks apply to both field and laboratory activities. The following discussion describes the various QC checks performed for field samples and laboratory activities.

9.1 FIELD QUALITY CONTROL CHECKS: For clients who bring sufficient volumes of samples for analysis or for projects in which REIC is responsible for field sampling, typically the field QC checks consist of equipment blanks, trip blanks (for VOAs only), and field duplicates. These field QC samples are analyzed for parameters of interest and are collected at frequencies determined by the project or according to recommendations presented in ***Table 9-1***. Field QC samples are counted as project samples, and the cost for sampling and/or analyses are applied accordingly.

9.1.1 TRAVEL (TRIP) BLANKS

Trip blanks are used to determine if any onsite atmospheric contaminants are seeping into the sample vials, or if any cross contamination of samples is occurring during shipment or storage of sample containers. Trip blanks are only analyzed for volatile organics.

Table 9-1 Field QC Checks

QC Samples	Water/Liquids	Soil/Sediment
Trip Blank (for VOA's only)	2 per Cooler	NR
Equipment Blank (rinsate)*	2 per Day	1 per Day
Field Duplicates: 1-4 Samples	NR	NR
5-9 Samples	5 % per Event	5 % per Event
>10 Samples	10 % per Event	10 % per Event
Split Samples**	----	----

Note: All parameters must meet QC sample type and frequency requirements. Numbers calculated from percent specifications will be rounded up to nearest whole numbers.

Abbreviations and Special Notes:
***NR** = Not Required.*

* *For long field activities in which samples are collected daily, only samples from every other day may be analyzed. Other samples are held and analyzed only if evidence of contamination exists.*

** *The requirement for split samples (reference duplicates) has not been defined. If split samples are needed, the frequency of collection will be provided in the site-specific quality assurance plan.*

volatile organics. The trip blanks consist of sample bottles filled in the laboratory with organic-free water

and any applicable preservatives. Trip blanks are sealed and placed in the ice chest. Trip blanks are sent to the sampling location with sampling kits and are returned unopened from the sampling location with the samples. Trip blanks should originate at the facility providing the blank water and sample containers. It is not necessary to take an aqueous trip blank when a nonaqueous medium is being sampled.

FREQUENCY: One trip blank (2 trip blanks for Drinking Water VOC's) should accompany each cooler containing VOCs samples, should be stored at the laboratory with the samples, and analyzed by the laboratory.

9.1.2 EQUIPMENT BLANKS

Equipment blanks (rinsates) are the final analyte-free water rinse from equipment cleaning, collected daily during a sampling event. An equipment blank is prepared by pouring target, analyte-free (deionized) water into or over the sampling equipment (bailers, tubing, soil samplers). The rinse water is collected in a sample container, preserved, and handled in the same manner as the samples.

FREQUENCY: One equipment blank should be collected each day samples are collected. For long drawn field sampling events, only samples from every other day may be analyzed. Other samples are held and analyzed only if evidence of contamination exists.

9.1.3 FIELD DUPLICATES

A field duplicate is a replicate sample collected and analyzed to demonstrate the reproducibility of sampling technique. A field duplicate is separate from the duplicate the laboratory must run and cannot be replaced by a laboratory-generated duplicate. Field duplicates are representative of field sampling precision, whereas laboratory duplicates are a measure of analytical precision. Both pieces of information are essential in determining the quality of data generated for a project.

A field duplicate is prepared at the sampling location from equal portions of sample aliquots combined to make the sample. Both the field duplicate and the sample are collected at the same time, in the same container type, preserved in the same way, and analyzed by the same laboratory as a measure of sampling precision.

FREQUENCY: Field duplicates should make up 10% of the samples collected.

9.1.4 SAMPLE SPLITTING

Sample splitting is performed when two or more parties want to have a portion of the same sample. A field split or referee duplicate is prepared at the sampling location from equal portions of sample aliquots combined to make the sample. Both the field split and the sample are collected at the same time, in the same container type, preserved in the same way. The split sample is submitted to a referee laboratory for analysis to assist in evaluating interlaboratory precision and the validation of the results.

FREQUENCY: Field splits to be determined by a client.

9.2 LABORATORY QUALITY CONTROL CHECKS

Internal laboratory control checks used by REIC are discussed in detail in each method performed. REIC

will demonstrate the ability to produce acceptable results using the methods requested. The minimum QC spike requirements for organic and inorganic analyses are presented in ***Table 9-2.***

9.2.1 HOLDING TIME

The amount of analyte in a sample can change with time due to chemical instability, degradation, volatilization, etc. If the specified holding time is exceeded the data generated may not be valid. Those analytes detected in samples analyzed past holding time requirements must be flagged as estimates.

	Standard Matrix		Sample Matrix				
Analysis	**Blank**	**Spike**	**Spike**	**Spike Duplicate**	**Sample Duplicate**	**Surrogate Spike**	**Filter Blank**
ORGANICS							
All Analyses (except TCLP)	0.05	0.05	0.05	0.05	NA	1	0.05
TCLP	0.05	0.05	+	NA	NA	1	0.05
INORGANICS							
pH	0.05	NA	NA	NA	0.05	NA	NA
Residues	0.05	NA	NA	NA	0.05	NA	NA
Turbidity	0.05	NA	NA	NA	0.05	NA	NA
Specific conductivity	0.05	NA	NA	NA	0.05	NA	NA
Dissolved oxygen	0.05	NA	NA	NA	0.05	NA	NA
TCLP	0.05	0.05	+	NA	NA	NA	0.05
All Other Analyses	0.05	0.05	0.05	0.05	NA	NA	0.05

Source: REI Consultants, Inc.

List of Abbreviations: NA = Not Applicable
+ = 5% or 1 per waste type, whichever is greater.

9.2.2 OPTIMUM BATCH SIZE

The laboratory will determine the optimum batch size. The optimum batch size is the number of samples of similar matrix, which can be processed concurrently through the entire preparation (i.e., extraction) and analysis. After the batch size is determined the QC criteria described in the following sections are followed.

9.2.3 CALIBRATION

All methods are calibrated prior to sample analysis ***(see Section 6.0)***. The following requirements are observed.

1. **Semi-volatiles, volatile organics, and Pesticides/PCBs analyses,** the current EPA methods (600 series) and SW-846 methods (8000 series) shall be used including frequency requirements, requirements for calibration check compounds (CCCs) and system performance check compounds (SPCCs).

   a. Tuning and performance criteria are established to ensure adequate mass resolution, proper identification of compounds, and to some extent - sufficient instrument sensitivity. These criteria are not sample specific. Instrument performance is determined using standard materials. Therefore, the mass tuning criteria must be met at all times. The tuning standard for volatile organics is bromofluorobenzene (BFB) and for semivolatiles is decafluorotriphenyl-phosphine (DFTPP). If the ion abundance criteria for a method are not met, all associated data must be classified as invalid (unusable).
   b. The response factor measures the instrument's response to specific chemical compounds. The response factor for the Target Compound List (TCL) must be equal or greater than 0.05 in both the initial and continuing calibrations. A value less than 0.05 indicates a serious detection and quantitation problem (poor sensitivity). Analyte in the sample will be qualified as an estimate.
   c. Percent RSD is computed from the initial calibration and is used to indicate the stability of the specific compound response over increasing concentration. Also, the percent recovery D is used to compare the response factor of the continuing calibration check to the mean response factor (RRF) from the initial calibration. Percent D is a measure of the instrument's daily performance. Percent RSD must be <30% and percent D must be <25%. A value outside of these limits indicates potential detection and quantitation errors. For these reasons all positive results are qualified as estimated.
   d. For the PESTICIDES/PCB analysis, %RSD for aldrin, endrin, DDT, and dibutychlorendate must not exceed 10%. Percent D must be within 15% on the primary quantitation column and 20% on the confirmation column.

2. **Other Methods of Analysis**

   a. At least three levels of concentration standards for each analyte shall be analyzed for initial calibration.
   b. The he correlation coefficient of the standard linear curve will be equal to or greater than 0.995.
   c. The midlevel calibration standard will be repeated at a frequency of 5% and at the end of a run.
   d. Response of the control analytes must be within ±20 percent of initial response.
   e. Detection limits for each parameter will be determined and checked annually to ensure they meet limits specified for the project.
   f. The calibration shall include one standard at a concentration at the level of the method detection limits.
   g. The calibration curve shall bracket all samples in the concentration range. GC/MS Calibration shall be checked every 12 hours of operation and prior to sample analysis.
   h. The laboratory shall use the calibration check acceptance criteria specified in the method.
   i. If samples are outside the calibration range, the laboratory shall appropriately perform dilution to bring the samples concentrations within the calibration range.

9.2.4 METHOD REAGENT BLANKS

Quality assurance (QA) blanks, i.e., trip blanks, equipment blanks, water blanks, and method (reagent) blanks, are designed to identify any contamination which may have been introduced into the

samples during field activity or sample preparation. Trip blanks measure cross-contamination of samples during shipment. Equipment blanks measure cross-contamination from the sampling equipment. Method (reagent) blanks measure laboratory contamination. If the concentration of the analyte is less than the method-quantifying limit, the analytes are qualified as non-detects. A method blank is analyzed for all methods with each sample batch.

9.2.5 SPIKES AND LABORATORY CONTROL MATRIX SPIKES (LCS)

In methods not using surrogates (metals, anions, wet chemicals), in addition to the method blank, a blank spike and a LCS are analyzed. In contrast to the blank spike being prepared from stock used to make the calibration standards, the Laboratory Control Matrix Spike is prepared from a different source. For pesticides/PCBs methods, surrogate compounds are employed. A method blank and Laboratory Control Matrix Spike are also analyzed with each batch as separate samples. A pesticide and/or PCB is used as a spiking compound.

In methods using surrogates spiked into all samples, the blank serves as both the method blank and the blank surrogate spike.

9.2.6 SECOND COLUMN CONFIRMATIONS

For all GC methods, second column confirmation or Mass Spectrometry is used for all positive responses in the primary column for the target analytes.

9.2.7 SURROGATE SPIKES

Surrogate spiking compounds are target analyte compound substitutes. The surrogates are chemically similar to the analytes of interest, and emulate their respective instrumental response. The surrogates do not interfere with the target analytes and are not naturally occurring in the environmental samples.

Surrogate spikes are performed for all methods for which surrogates are a customary procedure. Surrogate spikes monitor both the performance of the analytical system and the effectiveness of the method on the type of sample matrix. The surrogate compounds are spiked into each client sample, QC sample, standard, and method blank in a batch. Samples are spiked prior to sample preparation.

9.2.8 MATRIX SPIKE/MATRIX SPIKE DUPLICATES (MS/MSD)

Spiked samples are samples that have specific concentrations of analytes of interest added. Except for all Drinking Water analyses and metals, samples-specific MS/MSD are analyzed in all methods for every 20 samples of a similar matrix (either soil or water).

For metals analysis only, a matrix spike is required for every 20 samples of similar matrix. However, a matrix spike duplicate may be performed at the laboratory's discretion in lieu of a laboratory duplicate.

9.2.9 INTERNAL STANDARD PERFORMANCE

Internal standard (IS) performance criteria are designed to ensure that GC-MS sensitivity and response are stable during every analysis. The internal standard area count must not vary by more than a factor of 2 (-50% to +100%) from the associated continuing calibration standard. The retention time of the IS must

not vary by more than 30 seconds from the associated continuing calibration standard. If data is generated outside these criteria, all positive results for compounds quantitated using that IS are qualified as estimates.

9.2.10 COMPOUND IDENTIFICATION

For volatiles and semivolatile organics, the TCL compounds are identified on the GC-MS by using the analyte's relative retention time (RRT) and by comparison to mass fragmentation patterns obtained from known standards. For the results to be a positive hit, the sample peak must be within plus or minus 0.06 RRT units of the standard compound and have a mass fragmentation pattern which has a ratio of the primary and secondary m/e intensities within 20% of that in the standard compound.

For pesticides, the retention times of reported compounds must fall within the calculated retention time window for the two chromatographic columns.

Section 10.0

Systems & Performance Audits

10.0 Systems & Performance Audits

10.1 SYSTEMS AUDITS: A system audit is a qualitative evaluation of all components of a project (field and/or laboratory activities) to determine if each component is properly performed. The audits are designed to assure that systems and operational capabilities are maintained, and the study methodologies and quality control measures for the project are being followed as specified in the quality assurance project plan.

The QA Officer will conduct system audits on a quarterly basis. Audits of critical functions by the project QA staff will include:

a. Verification that standards, procedures, records, charts, data disks, etc., are properly maintained.
b. Verification that the actual practice agrees with written instructions. Methods must be selected so that all phases of a laboratory's effort is monitored, to include but not be limited to sample logging, chain of custody, sample preparation, standard preparation, extract storage and analysis, and data reduction.
c. Verification that QC/QA records are adequately filed and maintained so as to assure protection and retrievability.
d. Walk-through the laboratory for general observations.

10.2 PERFORMANCE AUDITS: Performance audits are quantitative evaluations of the components of a project or routine operations. Performance audits are used to evaluate the laboratory's ability to obtain accurate results in the analyses of known check samples by specific analytical methods.

10.2.1 INTERNAL PERFORMANCE AUDITS

Internal performance audits consists of analyses of commercially purchased QC check standards and/or in-house prepared QC check standards. Commercial suppliers give the options of confidential double blind evaluations or single blind with the certified results mailed along with standards. The stock solutions used to make in-house QC check standards are different from those used for calibration standards. The QC check samples are carried through the complete analytical preparation and analysis

and the calculated values are compared to the true target values. During the analytical data review, the QA officer pays close attention to these recoveries and must recommend corrective action in cases of repeated poor recoveries.

In addition to regular measurement of the QC check sample, the QA officer, on a quarterly basis, may introduce QC check samples for analyses with other project samples; blind to the analyst. The parameter groups are selected at random by the QA officer. The findings can form part of the quarterly audit report submitted to management.

10.2.2 EXTERNAL PERFORMANCE AUDITS

Laboratory performance audits are also performed in conjunction with the performance evaluation programs and performance testing (PT) samples administered by various agencies. REIC participates in the following programs: the State of West Virginia, Department of Environmental Protection - NPDES approval (Analytical Products Group Inc or APG), the U.S. EPA Water Pollution (WP) and Water Supply (WS) proficiency programs. Each of these programs requires the purchase of PT samples and evaluates results semiannually, excluding the APG PT program for which REIC participates on an annual basis.

10.3 MEMBERSHIPS, LICENSES, AND CERTIFICATIONS: The following is a list of memberships, licenses, and certifications held by REIC:

1. ***American Chemical Society.***
2. ***Associations of Analytical Chemists.***
3. ***West Virginia Petroleum Marketers Association.***
4. ***State of West Virginia Department of Health, Office of Environmental Health Services*** - - for Microbiology, Metals, Inorganics, Pesticides, Herbicides, THM, VOCs, and SOCs.
5. ***State of West Virginia Department of Commerce, Labor, and Environmental Resources, Department of Environmental Protection,*** Water Resources Section -- for Limited Inorganic Chemistry, Atomic Absorption, Microbiology, Limited Organic Chemistry, Demands, Organics, GC/MS, Characteristics, Organic Extractions, and Aquatic Toxicity.
6. ***Commonwealth of Virginia Department of General Services, Division of Consolidated Laboratory Services*** -- for Inorganics and Organics: Pesticides 1 and 2, Herbicides, Polychlorinated Biphenyls,

Trihalomethanes, VOCs 2 and 3, and SOCs 1-3 in water.

7. *Commonwealth of Kentucky Natural Resources and Environmental Protection Cabinet, Department of Environmental Protection* -- analyses of Inorganics, Secondary Standards, Organics, Total Trihalomethanes, Volatile Organics, and Unregulated Organics.
8. *State of Tennessee Department of Conservation, Division of Underground Storage Tanks.*
9. *State of Tennessee Department of Health and Laboratory Services* --for Trace Metals, other Inorganics, Pesticides and Herbicides, Other SOCs, Trihalomethanes, VOCs, Corrosivity and Sodium.
10. *North Carolina DEHNR Division of 00Solid Waste Management* -for Inorganics, Organics, TCLP, and MF Coliforms.

10.4 QA AUDIT REPORTS: The QA Officer shall provide a quarterly formal audit report comprised of summary findings to the President, Project Managers, and Vice Presidents. Deviations will be noted and discussed by management. The audit findings, both compliance and non-compliance, must be documented, filed in a secure place, maintained as part of the QA documentation. Minimally, these reports should include:

a. Periodic assessment of measurement quality indicators, i.e., data accuracy, precision, and completeness;
b. Results of internal and/or external audits;
c. Results of system audits;
d. Significant QA problems and recommended solutions.

Section 11.0

Preventive Maintenance

11.0 Preventive Maintenance

To ensure that instruments are operating properly at all times, REI Consultants, Inc., (REIC) follows a rigorous maintenance schedule and trouble-shooting procedures. All laboratory instruments undergo regular maintenance as required in the manufacturer's operation manual for each of the instruments. Trouble shooting protocols are also performed, if needed, for instruments according to instructions in the operation manual. Manufacturer service departments or local service repair companies provide repair. In the case of downtime of specialized instruments, service contracts with the manufacturer are maintained.

In the event of excessive downtime, REIC will either acquire instrumentation to complete project work or subcontract project work to fulfill project requirements.

11.1 MAINTENANCE DOCUMENTATION: Maintenance service contracts or internal maintenance logs are kept for each instrument. The maintenance log is kept near the instrument, so that preventive care or repair can be recorded immediately. All maintenance and repairs are documented in the instrument's logbook. The records include the date of maintenance or repair and description of work.

Other examples of the logbook entries are: name of the person providing the service, date, time, nature of service provided, notations, etc. Also, any applicable change in operation conditions, such as sensitivity, signal drift, temperature, corrections, alignments, etc, are recorded in the instrument's maintenance log book. For solvents, reagents, or gases, examples of log entries are: charting of the gas flow readings, gas pressure of cylinders, replacement dates of gas cylinders and water deionization cartridges, replacement of solvents, etc.

11.2 INSTRUMENT MAINTENANCE SCHEDULES:

11.2.1 Gas Chromatograph			
DAILY	COLUMN CHANGE	SEMIANNUALLY	AS NEEDED
Replace injector septum if necessary.	Check for leaks under pressure.	Wipe check ECD (performed by the manufacturer).	Bake out ECD.
Check and fill solvent rinse vials.	Check carrier gas flow through column with bubble flowmeter.	Reactivate or recharge flow controller filter dryers.	Leak test all gas fittings to cylinders.
Check cylinder and regulator output pressure.	Condition column overnight and run daily check.	Clean injector glass liners or replace as necessary.	Optimize gas flows to the FID.
Inspect gas filter driers, check flow through flow controllers.		Clean FID and align jet if necessary.	
Set and check injector, oven, and detector temperatures.			
Run a baseline for proper sensitivity and noise level to be used.			
Run solvent blank and standard solution, check for false peaks, bad retention times, baseline drift, poor peak shapes, and low sensitivity.			

11.2.2 HPLC
AS NEEDED
Dismantle the detector flow cell and clean.
Replace detector lamps according to manufacturer's recommendation.
Guard column frets and packings replaced when system pressure increases.
Replace piston seals and check valves.
Check and refill solvent containers.

11.2.3 Gas Chromatograph/Mass Spectrometer				
DAILY	WEEKLY	COLUMN CHANGE	SEMI-ANNUALLY	AS NEEDED
Check cylinder and regulator output pressure.	Replace injector septum if necessary.	Install a guard column.	Oil Turbo molecular pump wick.	Change the guard column.
Inspect gas filter driers, check flow through flow controllers, and adjust ionization gauge controllers.	Change inlet liner as needed.	Check for leaks under pressure.	Renew rough pump oil.	Auto manual tune the MS.
Set and check injector, oven, and detector temperatures.		Change the septum.		Recalibrate.
Check MS tuning, and run an auto/manual tune if necessary.		Condition column overnight and run daily check.		Clean up the MSD source.
Run solvent blank and standard solution, check for false peaks, bad retention times, baseline drift, poor peak shapes, and low sensitivity.				Clean up the injection port.
Check and fill solvent rinse vials.				

11.2.4 Atomic Absorption Spectrophotometer (AA)			
DAILY	WEEKLY	MONTHLY	ANNUALLY
Clean burner head/injection port.	Clean aspirator and nebulizer for deposits.	Examine O-rings in burner assembly and replace if necessary.	Schedule service visit by manufacturer to clean optics and for other maintenance.
Check water pressure.	Dust instrument exterior	Check cones in graphite furnace if necessary.	
Check gas pressures.	Check absorbance for line/element selection.	Inspect furnace cooling lines.	
Check & clean furnace optics if necessary.	Clean furnace.	Refill spray chamber reservoir.	
Inspect lamps for damage.			

11.2.5 Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES)				
DAILY	MONTHLY	QUARTERLY	AS NEEDED	ANNUALLY
Check nebulizer flow rate.	Refill argon humidification reservoir.	Clean filters.	Install new power tube, when the tube wears out.	Install new mirror.
Keep ICP exterior dust free.		Change cooling water reservoir.	Dust/clean instrument exterior and torch box.	Manufacturer's preventive maintenance.
Clean/flush nebulizer.		Clean & inspect torch/spray chamber.	Dust off intake and exhaust.	Change vacuum pump oil
Check vacuum pressure gauge. Record instrument operating parameters. Record zero position and reference wavelength.				

11.2.6 Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)				
Daily	Weekly	Monthly	Semi-Annually	Annually
Verify acceptable sensitivity & stability.	Perform mass calibration.	Clean extraction lens.	Examine lens stack and clean if necessary.	Replace detector (or as needed).
Record all settings and operational parameters.	Perform detector calibration	Check rotary pump oil levels.	Examine penning gauge & clean if necessary	
Properly dispose of both waste reservoirs (spray chamber drain & probe rinse drain).	Complete system tuning.	Check oil mist filters.	Change rotary pump oil.	
	Exchange/clean glassware.	Archive all analytical data on disks & then purge the data from the computer's hard drive.	Examine slide valve & check operation.	
	Check water filter & change if necessary. Check air filters & clean/exchange if necessary. Inspect pump tubing; replace if necessary.			

11.2.6 Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)				
Daily	**Weekly**	**Monthly**	**Semi-Annually**	**Annually**
	Inspect sample/skimmer cones & clean/ex change if necessary. Inspect all tubing/lines for degradation & leaks. Dust off the instrument & associated hardware.			

11.2.7 pH Meter, Conductivity Meters, Dissolve Oxygen, & Ion Specific Analyzer

11.2.7.1 pH Meter	
DAILY	AS NEEDED
Check the pH electrode tips for cracks. Analyze two calibration buffer standards & record results. (Aliquots of buffer standards shall be used only once.) Check the slope with a midrange standard buffer. Rinse electrode thoroughly between use and after use. Place the electrodes in storage buffer after use.	Solution refilled in the glass electrode. Replace the ceramic junction (Pentek pH meter).

11.2.7.2 Conductivity Meter & Conductance Bridge		
DAILY	ANNUALLY	AS NEEDED
Check and record the cell constant. Rinse the electrodes thoroughly between and after use. Place the electrode in the storage liquid after use.	Check the internal calibration with appropriate resistors (conductance bridge).	Make temperature correction. Clean according to the manufacturer's instructions (Bridge).

11.2.7.3 Dissolved Oxygen Meter	
DAILY	*AS NEEDED*
Call local National Weather Service for barometric pressure. Make corrections for barometric pressure and temperature. Record corrections and calibration results.	Refurbish O_2 sensor according to the manufacturer's instructions. Replace fill-solution and membrane.

11.2.7.3 Dissolved Oxygen Meter	
DAILY	*AS NEEDED*
Check that the stirring device is functioning properly. Protect the probes between and after use.	

11.2.7.4 Ion Specific Meter	
DAILY	*AS NEEDED*
Check the electrode tips for cracks or scratches. Calibrate with at least three standards and record results. Rinse electrode thoroughly between use and after use.	Make temperature corrections.

11.2.8 Analytical Balance and Electronic Balance	
DAILY	*AS NEEDED*
Clean weighing pan after each use. Return dust covering over the balance after use. Verify functional calibrations with Class S certified weights for analytical balances.	Bring in a qualified service and repair firm to service the balances.

11.2.9 Purge and Trap Autosampler

Check for system leaks, accumulation of dirt in purge chamber and degradation of trap. Clean or replace as needed.

11.2.10 Low Temperature Incubator		
DAILY	*QUARTERLY*	*AS NEEDED*
Check and record the temperature from the digital meter. Prevent bacterial contamination of the incubator.	Compare the meter to the lab thermometer traceable to NIST, and record the results.	Clean the incubator according to the manufacturer's instructions.

11.2.11 Norwalk Walk-in Coolers and Study Chambers		
DAILY	WEEKLY	QUARTERLY
Inspect the digital temperature readout device. Make sure the proper temperature is maintained. Check that the wheel chart needle is recording properly.	Check and record that the audible alarm is functioning. Replace and file the (7day) wheel chart-papers. Reorganize and clean the interiors.	Compare the monitors to the lab thermometer traceable to NIST, and record the results.

11.2.12 Working Thermometers (Glass/Mercury)	
DAILY	ANNUALLY
Check for continuity of the liquid column.	Compare each dedicated thermometer to the lab thermometer traceable to NIST, and record the results.

11.2.13 Deionized Water Units			
DAILY	QUARTERLY	ANNUALLY	AS NEEDED
Note the cartridge indicator reading.	Analyze for pH, Conductivity, Chlorine, and Bacteria.	Analyze for heavy metals; Pb, Cd, Cu, Cr, Ni, and Zn.	Change the cartridges when exhausted. Record the analyses results and any system changes.

11.2.14 Drying Ovens	
DAILY	ANNUALLY
Check and record the temperature (thermometer bulb in sand). Check that the door fits properly. Check and prevent sample cross contamination.	Compare the thermometer to the lab thermometer traceable to NIST, and record the results.

11.2.15 Muffle Furnace	
DAILY	QUARTERLY
Check and record the temperature setting. Check that the door fits properly. Check sure the fumes are properly exhausted.	Compare the meter to the lab thermometer traceable to NIST, and record the results.

11.2.16 LECO Tube Sulfur Analyzer
AS NEEDED
Calibrate with standards from a commercial supplier. Set and check the operating temperature. Check all tubing and the gas pressure. Clean the titration vessel after use.

11.2.17 Total Organic Carbon Analyzer

The injection septum is replaced every 100 (or less) injections. All pump tubes should be replaced at two-week intervals. Every two or three day's intervals check printer tape, infrared zero, and infrared span.

11.2.18 TOX/EOX Analyzer		
DAILY (check)	WEEKLY	MONTHLY
The exit tube and quartz wool. Bottom of titration cell inlet capillary - clean the cell. Lodged gas bubbles in the titration cell sidearms.	Change the quartz wool in the inlet liner and exit tube. Measure gas flow with a bubble flowmeter.	Check and clean the pyrolysis tube and titration cell. Check the inlets for cracks or discoloration and check the o-rings.

11.2.19 Spectrophotometer or Colorimeters	
DAILY	BIANNUALLY
Clean sample cells thoroughly or replace with new ones.	Verify the wavelength with a color standard or equivalent, and record results.

11.2.20 BOD Incubator		
DAILY	QUARTERLY	AS NEEDED
Check the digital meter and the inside thermometer. Make sure that thermometer bulb is immersed in liquid. Check that the door seals properly. Prevent bacterial contamination of the incubator.	Compare the meter to the Lab thermometer traceable to NIST.	Clean the incubator according to manufacturer's instructions.

Section 12.0

Calculation of Data Quality Indicators

12.0 Calculations of Data Quality Indicators

12.1 PRECISION: Precision is a measure of the degree of reproducibility of an analytical value and is used to check on the quality of the sampling and analytical procedures. Precision of the analytical method, at each stage, is determined by calculation of the relative percent difference (RPD) between duplicate analytical recoveries of sample component, relative to the average of those recoveries:

$$RPD = \{ | (R_1 - R_2) | / [(R_1 + R2)/2] \} x100$$

where: R_1 *and* R_2 *= concentration of Duplicates 1 and 2, respectively.*

Since an absolute value is used for the difference between R_1 and R_2, there is no lower control limit. These calculations are usually performed on sample matrix spikes and matrix spike duplicates and/or samples and respective sample duplicates. Each RPD value is compared with the precision criteria listed in Section 3.0.

12.2 ACCURACY: Accuracy is a degree to which a measurement agrees with the actual value (i.e., amount of measurement bias). Accuracy is expressed as a percent recovery of a sample's target value (known concentration of reference material). The accuracy of the analytical procedure is determined by the addition of a known amount of material (matrix spike) to a field sample matrix or a Laboratory Control matrix. A Laboratory Control matrix is made up of deionized (distilled water) or clean soil (of known physical and chemical properties). Percent recovery is calculated as follows:

$$R = [(xs - x_u)/K] \; x100$$

Where

R = *% Recovery*
x_s = *the measured value for the spiked sample*
x_u = *the measured value for the unspiked sample, and*
K = *the known value of spike in the sample.*

If RPD or R-values do not meet acceptance criteria as specified in Section 3, results reported in all samples processed as part of the same set must be labeled as suspect, and the sample analysis may need to be repeated. The laboratory QA officer will be notified, and the necessary corrective action will be implemented.

12.3 COMPLETENESS: Completeness is a measure of the amount of data obtained from a measurement system compared to the amount that was expected to be obtained. Analytical completeness is assessed by comparing the total number of samples with valid analytical results to the number of samples collected and delivered to the laboratory. The result is calculated following data validation and reduction. Completeness (C) is determined by:

$$C = S2/S_1$$

where: S_1 = *total number of samples planned, and*

S_2 = *number of valid data points.*

A value of 95% or higher is the goal. For values less than 95 percent, problems in the analytical procedures must be examined and possible solutions explored.

12.4 DETECTION LIMITS: When analytical measurements fall below the confidence level, the results are reported as "non-detects" (ND). This level can be: the Minimum quantifying level (MQL), practical quantitation limit (PQL), or method detection limit (MDL). The choice is base upon the needs of the client, objectives of the project, and requirements of the regulatory agency. The MQL is the concentration of an analyte that can be measured and reported based on the sample matrix. The MQL may be 2 to 10 times greater than the MDL.

The PQL is the lowest concentration level that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions.

The MDL is the minimum concentration of a substance that can be reliably recovered in a sample matrix, distinguished from the background noise level, and reported with a 99% confidence that the analyte concentration is greater than zero.

For unknown or difficult matrices, REIC laboratory will either determine or use the MDL(s) provided in the EPA analytical methods being employed. When determining MDL's, the analyst uses the procedures given in 40 CFR Part 136, Appendix B. (REIC's MDL's are calculated on an annual basis.)

The detection limit is defined as follows for all measurements:

$$\boxed{MDL = t_{(n-1,\, 1-\alpha = 0.99)} \times S}$$

where:	*MDL*	=	*method detection limit*
	S	=	*standard deviation of the replicate analyses*
	t (n-1, 1-α=0.99)	=	*Students' t-value appropriate to a 99 percent confidence level and a standard deviation estimate with n-1 degrees of freedom*

12.5 CONTROL CHART PROCEDURES: For selected parameters, as precision data is accrued, parameter and matrix specific control charts are generated. The average RPD (P') and the standard deviation (Sp) of the RPD will be recalculated. In a precision control chart, the assessment is expressed as a RPD interval from zero to:

$$P' + [(3)\, S_p] = \textit{precision control level.}$$
$$P' + [(2)\, S_p] = \textit{precision warning level.}$$

For the accuracy control charts, the average percent recovery (R') and the standard deviation (S_r) of the average percent recovery will be recalculated for selected parameters and matrices.

The accuracy assessment is expressed as percent recovery interval from:

$$R' + [(3)\, S_r] = \textit{upper control level.}$$
$$R' + [(2)\, S_r] = \textit{upper warning level.}$$

down to:

$$R' - [(2)\, S_{lr}] = \textit{lower warning level.}$$
$$R' - [(3)\, S_r] = \textit{lower control level.}$$

The precision and accuracy control charts for selected parameters will be updated on a regular basis. After each five to ten new measurements are added, the average of the most current twenty to thirty data points and the standard deviation of the average will be updated.

Section 13.0

Corrective Action

13.0 Corrective Action

13.1 FIELD ACTIVITIES: Field activities that are improper will be corrected as quickly as possible. The project field manager or designated field team leader will be responsible to see that corrective action is initiated and documented; whenever the error has the potential to compromise the quality of the data being generated or there is a chance that the error might be repeated. The project QA Officer can also make recommendations, during the field audits or field data reviews, to the field manager who can ensure immediate implementation. The corrective action report must document in detail the nature of the problem, proposed corrective action, who is responsible for executing it, and who will verify that it was carried out.

Examples for frequently measured parameters in the field and limits to which they should agree (as determined by replicate measurements or prior expectations) include:

1. pH determination should agree within 0.02 pH units.
2. Conductivity measurements should agree within 2 numbers of the last significant digit.
3. Depth to water level determinations/readings should agree within 0.01 foot.

If re-measurements are not successful, then instrument calibration and operation and the field analyst technique should be evaluated.

13.2 LABORATORY ACTIVITIES: When through audits or QC sample analysis results, the performance of analytical systems is found to be unsatisfactory, corrective action will be initiated. The Project Manager, Laboratory Director (or Assistant Laboratory Director), Project Chemist, Analyst, and QA Officer may be involved in the corrective action. For corrective actions that will impact the project budget or schedule, the directors and/or the project manager must be closely involved. There are two kinds of corrective action:

1. Immediate corrective actions are taken to correct or repair nonconforming equipment and systems. The need for such action is likely to be identified by the analyst through calibration checks and spike analyses.

2. Long-term corrective actions are taken to eliminate causes of nonconformance. The need for such a corrective action may be identified through audits. Examples of this type of corrective action include:

    a. Identifying vendors to supply reagents of sufficient purity;
    b. Rescheduling of field activity or laboratory routine to ensure that samples are always analyzed within the correct holding time; and
    c. Personnel training or replacement.

13.3 CORRECTIVE ACTIONS PROCEDURES: For either immediate or long-term corrective actions taken as a result of non-conformance in field and laboratory activities, the procedure is as follows:

1. Define the problem;
2. Assign the responsibility to appropriate personnel to investigate the problem;
3. Find and describe the cause of the problem;
4. Determine the appropriate corrective action to eliminate the problem;
5. Assign and accept responsibility for implementing the corrective action;
6. Establish the effectiveness of the suggested corrective action and implement the correction; and
7. Verify that the corrective action has achieved its goal and the problem has been eliminated, i.e., in the preparation of new standard or calibration solutions, provided the results of the old together with the new calibration standards verify that the problem as been eliminated.

Specific corrective action procedures per method are further discussed in REIC's SOPs.

Section 14.0

QA Report to Management

14.0 Quality Assurance Reports to Management

The Director will be updated of the quality control procedures and results of field and laboratory operations. Oral reports will be on a weekly basis and formal detailed reports on a monthly basis (or sooner, if needed). The quality assurance report issued as part of the report to the client shall be retained as part of the project file and may not be available for review by any other external auditor other than the client.

Management shall also receive quality assurance reports as they are obtained from external systems or performance audits.

The QA officer will provide a formal report to management on a monthly basis. The report may include:

- Overall over-view of the progress of the QA program.
- Changes in the project specific QA plans, training, and accomplishments.
- Summaries of field audits and laboratory quarterly audits
- Summaries of findings of monthly analytical data packages review.
- Significant QA/QC problems, recommended solutions, and results of corrective actions.
- Response to external audit findings and any corrective action implemented.

Section 15.0

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15.0 References

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16. *Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration;* Document No(s). *ILM 04.0,* 1994 and *ILM03.1,* 1992; U.S. EPA.
17. *Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration;* Document Nos. *OLM01.0,* 1990; with revisions inclusive of *OLM01.8,* August 1991; and *OLM 03.0* and inclusive *OLM 03.1* and it's attachments, Aug. 1994; U.S. EPA.
18. *Superfund Analytical Methods for Low Concentration in Water for Inorganics Analysis;* Oct. 1991, U.S. EPA.
19. *Superfund Analytical Methods for Low Concentration in Water for Organics Analysis;* Oct. 1992, U.S. EPA.
20. *Code of Federal Regulations;* Part 503 (40 CFR 503); for EPA Standards for the Use or Disposal of Sewage Sludge; subscription to "BNA Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.

21. *Publicly Owned Treatment Works (POTW) Sludge Sampling and Analysis Guidance Document;* Office of Water Permits Division; 1989; U.S. EPA.
22. *Drinking Water Monitoring and Analytical Requirements, Coliform Sampling;* Title 40, Part 141, Subpart C of the **Code of Federal Regulations**(40 CFR 141.21); monthly subscription to "BNA Environment Reporter"; Bureau of National Affairs, Inc., Washington, DC.
23. *Short-Term Methods for Estimating the Chronic Toxicity of Effluent and Receiving Waters to Freshwater Organisms, 3rd Edition;* EPA/600/4-91/002, July 1994; Environmental Monitoring Systems Laboratory, U.S. EPA, Cincinnati, OH.
24. *Short-Term Methods for Estimating the Chronic Toxicity of Effluent and Receiving Waters to Marine and Estuarine Organisms, Third Edition;* EPA/600/4-91/003, July 1994; Environmental Monitoring Systems Laboratory, U.S. EPA, Cincinnati, OH.
25. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD);* OSWER-9950.1, Sept. 1996; updated by **RCRA Ground-Water Monitoring: Draft** *Technicl Guidance;* EPA/530/R-93/001, Nov. 1992; Office of Solid Waste, U.S. EPA.
26. *Region II CERCLA Quality Assurance Manual;* Revision 1; U.S. EPA 1989.
27. *Contract Laboratory Program Statement of Work for Organic Analysis, Low Concentration Water;* Document No. OLC02.0, March 1995; U.S. EPA.
28. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses;* July 1988, Hazardous Site Evaluation Division, U.S. EPA.
29. *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses;* EPA/540/R-94/082, Dec. 1994, Hazardous Site Evaluation Division, U.S. EPA.

APPENDIX E QC Documentation

Quality Control Review Checklist

Stabilization, Excavation and Disposal of Contaminated Soil
Plum Brook Ordnance Works
Sandusky, Ohio

The following checklist is provided for QC review of the Plan of Operations for this project.

1.	Project Description	_____
2.	Project Organization and Responsibilities	_____
3.	Applicable, Relevant, and Appropriate Requirements	_____
4.	Field Activities	_____
5.	Analytical Requirements	_____
6.	Equipment Decontamination	_____
7.	Field Documentation Procedures	_____
8.	Sample Packing and Transportation	_____
9.	Contractor Chemical Quality Control	_____
10.	Daily Quality Control Reports	_____
11.	Corrective Action	_____
12.	Spill Prevention, Containment, and Countermeasure Plan	_____
13.	Protection of Rivers, Streams, and Impoundments	_____
14.	Air Emissions	_____
15.	Project Schedule	_____
16.	References	_____

APPENDICES

Appendix A	Scope of Work	_____
Appendix B	Site Map	_____
Appendix C	Field Activity Forms	_____
Appendix D	Laboratory QA Plan	_____
Appendix E	QC Documentation	_____

QUALITY ASSURANCE CERTIFICATION

DRAFT
PLAN OF OPERATIONS

Stabilization, Excavation and Disposal of Contaminated Soil
Plum Brook Ordnance Works
Sandusky, Ohio

Contract No. DACW69-00-D-0021
Work Order No. 020

This document is provided to certify that the Independent Quality Control Team (IQCT) have reviewed the Plan of Operations in accordance with the Quality Control Plan. All comments resulting from the various reviews have been resolved and/or incorporated.

Assignment	Name	Signature	Date
Senior Review	David Beam		8-1-02
Peer Review	Chris Burke		8-1-02
Project Manager Review	Steve Arbogast		

QUALITY ASSURANCE CERTIFICATION

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Assignment	Name	Signature	Date
Senior Review			
	David Beam	_____	_____
Peer Review			
	Chris Burke	_____	_____
Project Manager Review			
	Steve Arbogast	_____	7-31-02

Comments on Draft Plan of Operations

Stabilization, Excavation and Disposal of Contaminated Soil
Plum Brook Ordnance Works
Sandusky, Ohio

The following comments were provided by the WasteTron Independent Quality Control Team (IQCT). All comments resulting from this review has been resolved and/or incorporated.

1. Cover sheet: Change date to August 2002

Response: Concur, change made

2. Page 1; third paragraph; fifth sentence: This sentence sounds awkward. Consider rewording.

Response: Concur, change made

3. Page 2; first paragraph; third sentence: Consider inserting "and" after "...buildings by fire,". Also in this sentence, should there be a comma after "...removal of all soil"?

Response: Concur, change made

4. Page 3; first paragraph; sixth sentence: Consider removing the comma after "...may be classified,".

Response: Concur, change made

5. Page 8; item F.: The contact name and phone number are not aligned properly.

Response: Concur, change made

6. Page 9; items H and K.: The hyphens after the company names are not like those in the other items.

Response: Concur, change made

7. Page 10; section 3.1; third sentence: There is no period after this sentence. Also the fourth sentence is a run-on, consider rewording for readability.

Response: Concur, change made

8. Section 3.2: Should the EPA PRGs also be listed in the ARARs? If so, please add to this section.

Response: Concur, change made

9. Page 11; Section 4.2; second paragraph; sixth and seventh sentences: Should the three "would be" s in these sentences be "will be". Other aspects of this phase of the work is stated as "shall be" or "will be" done, and therefore "would be" seems inconsistent with the context.

Response: Concur, change made

9. Page 12; first paragraph; first sentence: Consider changing "...and store it on-site." to "...where it will be stored for future use." Also in the second sentence, change "...anticipated that is..." to "...anticipated that it...".

Response: Concur, change made

11. Page 13; section 4.3.1; second paragraph; first sentence: Consider changing "...forms, stable..." to "...forms that are stable...".

Response: Concur, change made

12. Page 13; section 5.0; last sentence: There is no period after this sentence.

Response: Concur, change made

13. Page 14; section 5.2; first paragraph; second sentence: Consider changing "...limits has been..." to "limits have been...". Also in the third sentence, change "...determination has made," to "...determination has been made,". Additionally, there appears to be two periods after the last sentence in this paragraph.

Response: Concur, change made

14. Page 14; section 5.2; second paragraph; second sentence: Consider changing "...from a wall that is..." to "...from an excavation that is...". Also apply this comment to the fourth sentence in this paragraph.

Response: Concur, change made

15. Page 15; last sentence on this page: Consider changing "...of the wall and floors..." to "...of the walls and floor...".

Response: Concur, change made

16. Page 20; third paragraph; last sentence: Remove the ")" after "IDW".

Response: Concur, change made

17. Page 21; section 7.2; first sentence: Change "al" to "all".

Response: Concur, change made

18. Page 23; section 8.0; 6th and 8th bullets: Should "laboratories" be "laboratory"?

Response: Concur, change made

19. Section 4.3; 3rd paragraph; There is no defined criteria for deciding whether hazardous waste soil will be treated on-site or disposed off-site. It seems that it would be best to establish this criteria prior to beginning excavation activities. If the deciding factor is financial limitation, then perhaps there could be a threshold volume of hazardous soil that would trigger the on-site treatment option. In addition, if on-site treatment is being proposed as an option, then the selected remediation process and procedure should be included in the plan.

Response: Lead contaminated soil will be treated on-site with Maectite. Nitroaromatic contaminated soil that fails the TCLP analysis for any TCLP constituent other than lead may be treated on-site or it may be disposed at EQ Environmental's Wayne Disposal Facility in Michigan. Determining factors for potential treatment on-site will be the amount of soil failing the TCLP analysis, the contaminant(s) of concern type, and concentration of the contaminant(s). Since these are not known, the selection and procedures for a remediation process is not something that can be included in the plans. WasteTron intends to dispose of hazardous soils at a hazardous landfill unless the USACE and/or NASA would want to perform on-site treatment.

20. . General comment on field screening; Consider adding a section that describes QCC practice for field screening that would include a procedure to follow if questions or problems are encountered in the field screening process.

Response: Refer to top of page 17 that indicates that the Project Manager will make the decision on whether or not to stop field screening and send confirmatory samples to the lab .

Comments on Draft Plan of Operations

Stabilization, Excavation and Disposal of Contaminated Soil
Plum Brook Ordnance Works
Sandusky, Ohio

Contract No. DACW69-00-D-0021
Work Order No. 020

The following comments were provided by the Huntington District of the USACE. All comments resulting from this review has been resolved and/or incorporated.

The Huntington District had no comments, the following are comments from Bob Lallier at NASA.

Plan of Operations

1. Pg 16, Table 3 - Please review to make sure that North East Nail House doesn't also have lead concerns. It seems to be mentioned elsewhere in the report as having metals concerns. Revise as appropriate.

Response: Concur, this was changed to reflect that sampling would be performed at the North East Nail House

2. Please add to the Plan of Operations that NASA will have to sign the manifests for all "hazardous" waste that will be leaving the site. For non-haz manifests, the COE or Contractor may sign. Revise as appropriate.

Response: Concur, the following statement was added to Section 5.3

NASA personnel must sign manifest for all hazardous waste removed from the site. USACE or WasteTron personnel may sign non-hazardous manifests.