Closed-Loop Bioreactor Pilot Study Implementation Plan

Naval Weapons Industrial Reserve Plant
Plant 3, Area of Concern 22
Bethpage, New York

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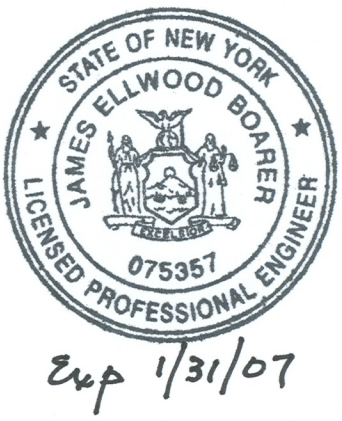

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

µg/kg.....microgram per kilogram
µg/L .....micrograms per liter
AOC .....Area of Concern
ARAR .....Applicable or Relevant and Appropriate Requirement
AS .....air sparging
bgs.....below ground surface
BTEX.....benzene, toluene, ethylbenzene and xylenes
CERCLA.....Comprehensive Environmental Response, Compensation, and Liability Act
cfm .....cubic feet per minute
CFR.....Code of Federal Regulations
CLB.....Closed-Loop Bioreactor
CLEAN .....Comprehensive Long-Term Environmental Action Navy
CMS .....Corrective Measures Study
COC .....contaminant of concern
CTO .....Contract Task Order
EFANE .....Engineering Field Activities Northeast
FFS.....focused feasibility study
FS.....feasibility study
GAC.....granular-activated carbon
GRA.....general remedial action
HPC.....Heterotropic Plate Count
IAS.....Initial Assessment Study
IR .....Installation Restoration
ISTD .....in-situ thermal desorption
MCL.....Maximum Contaminant Level
mg/kg .....milligram per kilogram
mg/L.....milligrams per liter
MW .....megawatts
NAVFAC.....Naval Facilities Engineering Command
NCP.....National Contingency Plan
NFESC.....Naval Facilities Engineering Service Center
NPW .....net present worth
NWIRP .....Naval Weapons Industrial Reserve Plant
NYCRR.....New York Codes, Rules and Regulations
NYSDEC .....New York State Department of Environmental Conservation
O&M.....operation and maintenance
OSHA .....Occupational Safety and Health Administration
OVA.....organic vapor analyzer
PA .....preliminary assessment
PAH .....polycyclic aromatic hydrocarbon

PHD .....Petroleum Hydrocarbon Degraders
PPE .....personal protective equipment
PRG.....preliminary remediation goal
RAB .....Restoration Advisory Board
RCRA .....Resource Conservation and Recovery Act
RFA.....RCRA Facility Assessment
RFI .....RCRA Facilities Investigation
RI .....remedial investigation
SI.....site investigation
STARS.....Spill Technology and Remediation Series
SVE.....soil vapor extraction
SVOCs .....semivolatile organic compounds
SW-846.....Test Methods for Evaluating Solid Waste
SWMU.....Solid Waste Management Unit
TAGM.....Technical and Administrative Guidance Memorandum
TBC.....to be considered
TCE.....trichloroethene
TCL.....Target Compound List
TESVE.....thermally-enhanced soil vapor extraction
TPH.....total petroleum hydrocarbons
TtNUS.....Tetra Tech NUS, Inc.
USEPA.....United States Environmental Protection Agency
UST.....underground storage tank
VOC.....volatile organic compound

CLOSED-LOOP BIOREACTOR PILOT STUDY IMPLEMENTATION PLAN

1. GENERAL DESCRIPTION

1.1. Purpose and Scope

Locus Technologies (Locus) has prepared this Closed-Loop Bioreactor Pilot Study Implementation Plan to address soil and groundwater pilot study activities at the former Underground Storage Tanks (USTs) (Area of Concern [AOC] 22) south of Plant No. 3 Naval Weapons Industrial Reserve Plant (NWIRP) in Bethpage, New York, (see Figures 1-1 and 1-2). This report was prepared for the United States Navy (Navy) Engineering Field Activities Northeast (EFANE) Naval Facilities Engineering Command (NAVFAC) for the Naval Facilities Engineering Service Center (NFESC) broad agency announcement Contract Number N47408-04-C-7505.

This document provides the following items for the implementation of the selected pilot study to be conducted at AOC 22:

- A general description of the location and history of the site, the chemicals of concern (COC) to be remediated, and an overview of the selected pilot study technology
- An outline of the necessary design tasks
- A design summary highlighting the results of each of the design tasks performed to accomplish the objectives of the selected pilot study
- A summary of the construction strategy addressing critical components of construction activities required to implement the remedial design

- Requirements for health and safety, waste management, contamination control, decontamination, quality assurance, quality control inspections, performance verifications (sampling and analysis), post-construction operations, maintenance and institutional controls, project closeout, post-construction monitoring, and a forecast schedule for implementation of the corrective measures

1.2. General Description and History of the Unit

The NWIRP Bethpage is located on Long Island, New York, on a relatively flat, featureless, glacial outwash plain. The site and nearby vicinity are highly urbanized. Because of this, most of the natural physical features have been reshaped or destroyed. The topography of the activity is relatively flat with a gentle slope toward the south. Elevations range from greater than 140 feet above mean sea level (msl) in the north to less than 110 feet above msl at the southwest corner.

The USTs were reportedly removed sometime between 1980 and 1984. Environmental concerns for this area are based on the results of site investigations conducted in 1997 and 1999. The 1997 investigation found evidence of petroleum in the soils from near the bottom of the former USTs to depths near the water table (UST Nos. 03-01-1, 2, and 3). A second investigation conducted in 1999 included the installation of groundwater monitoring wells, and the subsequent discovery of free petroleum product on the groundwater table.

The NWIRP is approximately 108 acres in size. The dominant features at the site are Plant No. 3 (the manufacturing plant) and three groundwater recharge basins. The recharge basins are each approximately 1.5 to 2.5 acres in area and about 30 feet deep.

In 1997, Northrop Grumman conducted a soil investigation at the former UST location AOC 22. During this investigation soil borings were installed around and under the former tanks. Approximately 144 soil samples were collected in eight areas from depths of 8 to 65 feet below ground surface (bgs). This range represents soils from the bottom of the former USTs to the approximate water table. The samples were analyzed for petroleum-based volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) in accordance with the New York State Department of Environmental Conservation (NYSDEC)

Spill Technology and Remediation Series (STARS) Memorandum No. 1 – Petroleum-Contaminated Soil Guidance Policy (August 1992) and for Total Petroleum Hydrocarbons (TPH). Soil boring locations are indicated on Figure 1-2.

In 1999, 14 soil borings were drilled under the supervision of Tetra Tech NUS, Inc., to investigate the vertical and horizontal extent of potential free petroleum product within the area of concern. Five borings were converted to groundwater monitoring wells, based on field observations concerning the presence of free product. Groundwater was encountered at approximately 55 to 57 bgs during drilling. Two borings (MW01 and MW02) were installed in close proximity to the suspected source area. Monitoring Wells MW03 and MW04 were installed near the boundary of the area of concern, in soil borings that showed limited evidence of free product. Well MW-5 was installed inside Plant No. 3. Following installation, all of the wells were developed, and a top-of-casing elevation survey was completed. Soil boring locations are included on Figure 1-2. Monitoring well locations are indicated on Figure 1-3.

Rising-head slug tests were performed on three of the monitoring wells to determine hydraulic conductivity (K) values. Composite free product samples were collected from accumulated well development and purge water at the conclusion of field activities.

1.3. Nature and Extent of Contamination

The nature and extent of contamination at the site have been determined based on the laboratory analytical results of subsurface soil and groundwater samples collected from AOC 22 in previous investigations conducted by Tetra Tec NUS, Inc. (Figures 1-2, 1-3, and 1-4).

1.4. Soil and Groundwater Contamination

Laboratory analytical results from the 1997 investigation indicated TPH in soils at concentrations up to 18,000 milligrams per kilogram (mg/kg) and at depths near the groundwater table. The petroleum hydrocarbons were predominantly of the diesel range organics (DRO) that are consistent with the No. 4 and No. 6 fuel oils reportedly used at this location. VOCs were detected infrequently in the soil samples, and only benzene, at a maximum concentration of 150 micrograms per kilogram (µg/kg) exceeded the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 soil remediation

criteria. SVOCs were detected more frequently. The maximum reported SVOC concentration was pyrene at 32,000 µg/kg. Benzo(a)anthracene (4,300 µg/kg), benzo(a)pyrene (2,700 µg/kg), chrysene (7,500 µg/kg), and dibenzo(a,h)anthracene (450 µg/kg) exceeded the respective TAGM remediation criteria.

During the 1999 investigation, TPH concentrations were highest in samples collected at depths of 55 to 57 feet bgs from Borings SB01, SB02, SB03, and SB04, which are located in close proximity to the former UST location. TPH DRO concentrations were 1,900 mg/kg in Boring SB01, 21,000 mg/kg in Boring SB02, 13,000 mg/kg in Boring SB03, and 12,000 mg/kg in Boring SB04. DRO concentrations were also reported in Boring SB05, located inside Plant No 3, Boring SB12, located north of Plant No. 3, and Boring SB07, located approximately 60 feet southwest of the former UST area. Gasoline range hydrocarbon (GRO) concentrations were significantly lower, with concentrations ranging from non-detectable to a high concentration of 250 mg/kg in Boring SB04.

VOCs were detected only in Boring SB08 at a depth of 55 feet bgs. Acetone was reported at a concentration of 5.1 µg/kg, and methylene chloride was detected at 2.8 µg/kg. Both of these concentrations may be the result of laboratory contamination and likely do not represent actual site conditions.

SVOCs were reported in the soil sample collected from Boring SB05 at a depth of 55 feet bgs. The highest concentration was reported for 2-methylnaphthalene (3,200 µg/kg). Phenanthrene was reported at 2,800 µg/kg, and fluorene was detected at a concentration of 670 µg/kg. Chrysene and Pyrene were reported in a duplicate sample from Boring SB05 at concentrations of 980 µg/kg and 2,300 µg/kg, respectively. Phenanthrene was reported in Boring SB01 at a concentration of 3,000 µg/kg. Only the chrysene concentration exceeded the NYSDEC Technical and Administrative Guidance Memorandum Number 4046 (TAGMs) soil remediation criteria.

In general, petroleum hydrocarbon-impacted soils appear to be confined to an area within approximately 60 feet of the former UST area, with the primary COC being TPH in the diesel range. Volatile and semi-volatile compound concentrations are not wide spread, and do not appear to be a significant contaminant.

Maximum concentrations of detected constituents in groundwater, and their respective Remedial Action Goals are presented in Table 1. A complete list of soil sample laboratory analytical results is included in on Figure 1-4.

A complete list of analytical results for groundwater samples collected from the five monitoring wells is included in Appendix A. Results indicated benzene, ethylbenzene, total xylenes, and naphthalene concentrations exceeding the NYSDEC groundwater remediation criteria in well MW-01, located immediately downgradient (southwest) of the former UST area. Benzene, ethylbenzene, and naphthalene exceeded the remediation criteria in Well MW-02. Benzene also exceeded the remediation standard in downgradient Well MW-04. The highest concentrations for benzene (17 µg/L), ethylbenzene (18 µg/L), total xylenes (7.6 µg/L), and naphthalene (20 µg/L) were detected in Well MW-01. Although the maximum down gradient extent of contaminant concentrations exceeding the remediation criteria has not been determined, analytical results indicate that the contaminants of concern attenuate significantly in the down gradient direction. In Well MW-04, located approximately 50 feet down gradient of Well MW-01, benzene was reported at a concentration of 4.1 µg/L. Ethylbenzene and total xylenes did not exceed the laboratory reporting limits, and naphthalene was reported at a concentration of 2.5 µg/L.

Free petroleum product was reported in Wells MW-01 and MW-02 following installation of the monitoring wells. The maximum observed thickness was 0.02 feet.

In addition to the petroleum hydrocarbon constituents discussed above, several chlorinated solvents were reported in the monitoring wells. The highest concentrations of these compounds were reported in upgradient Wells MW-03 and MW-05, indicating that the chlorinated solvents are migrating into the AOC 22 area from another source.

1.5. Pilot Study Objectives

Pilot study objectives have been developed to address contaminated soil and groundwater at AOC 22. In general, Pilot study objectives identify COCs, receptors, pathways, and action levels relevant to the facility, and are based on the results of the site investigation.

The primary soil COC identified during the investigation is TPH. The pilot study objectives for contaminated soil are as follows:

- Mass removal of petroleum hydrocarbons
- Prevent human exposure to soil contaminated with SVOCs at concentrations greater than the NYSDEC TAGMs
- Prevent leaching of contaminants that would result in groundwater concentrations greater than the NYSDEC TAGMs

The attainment of the soil pilot study objectives will be accomplished through the removal of TPH mass by the method described in Section 1.6. Based on the results of the previous investigations, Tetra Tech NUS, in a *RCRA Facility Assessment/Focused Feasibility Study (FA/FFS)* dated February 2002, estimated the volume of TPH and Polycyclic Aromatic Hydrocarbons (PAH) contaminated soil in the vadose zone to be 16,900 cubic yards. The estimated volume of contaminated soils in the saturated zone is 8,000 cubic yards. The total estimated mass of TPH between the depths of 8 and 66 feet bgs is 244,000 pounds.

Based on historical activities within the AOC 22 area and laboratory analytical results from the previous investigations, the following pilot study objectives for groundwater have been established:

- Prevent human exposure to groundwater having contaminants originating from AOC 22 at concentrations greater than the established remedial action levels
- Prevent further migration of contaminants originating from AOC 22

The maximum observed groundwater contaminant concentrations, and ultimate remedial action goals established for groundwater at AOC 22 are indicated in Table 1. VOCs detected in groundwater at concentrations exceeding the remedial action levels are benzene, cis-1,2-dichloroethene (cis-1,2-DCE), 1,2-dichloroethene (1,2-DCE), ethylbenzene, tetrachloroethene (PCE), trichloroethene (TCE), trichlorotrifluoroethane, vinyl chloride (VC), and xylenes. Cis-1,2-DCE, 1,2-DCE, ethylbenzene, PCE, and TCE were detected in upgradient monitoring wells. The maximum concentrations of PCE and TCE

were reported in upgradient wells. Based on this, it does not appear the occurrence of these contaminants is related to activities at AOC 22. Although VC was not detected in upgradient wells, its occurrence is likely due to natural biodegradation of PCE and TCE. In addition, groundwater remediation for chlorinated solvents that are not related to activities at AOC 22 is being addressed in an unrelated facility-wide program under the auspices of the NYSDEC.

The only SVOC detected at a concentration above its respective remedial action goal is bis (2-ethylhexyl) phthalate, the maximum concentration of which was detected in an upgradient well. Thus, it appears that this contaminant is unrelated to activities at AOC 22. None of the PAHs detected in soil samples were present in the groundwater at concentrations exceeding the remedial action goals.

Attainment of the groundwater pilot study objectives will be achieved in two phases during the remedial process. Free product, if it still present within the AOC 22, will be removed from the treatment area within approximately 90 days following remedial system startup. It is anticipated that attainment of the soil pilot study objectives through removal of contaminant mass in the vadose zone will result in the protection of groundwater from further impact due to activities at AOC 22, and subsequent achievement of the groundwater pilot study objectives within a 12-month period.

1.5.1. Sensitive Receptors

The AOC 22 is located within the confines of the larger NWIRP. The local groundwater gradient beneath the site is toward the south-southwest (Figure 1-3) (TetraTech NUS, Inc., 2002). There are no sensitive receptors (drinking supply wells, schools, residential areas, hospitals, etc) located within 500 feet downgradient of the AOC 22. The nearest residential neighborhood is located approximately 600 feet west-northwest of the AOC 22.

1.5.2. Migration Pathways

Exposure to the COC could potentially occur through inhalation, ingestion, and dermal contact. Given the depth of contaminated soils (greater than 10 feet) and the nature of the contaminant (No. 4 and No. 6 fuel oil), it is highly unlikely that on-site or off-site receptors of vapor exist. The potential for ingestion and dermal contact would exist if groundwater impacted with fuel oil No. 4 or fuel oil No. 6 was pumped

through a well for irrigation, municipal, or domestic use. However, no irrigation, municipal, or domestic use wells are located within 500 feet of AOC 22. Because the fuel oils are heavy molecular weight hydrocarbons and relatively insoluble in water, the COC emanating from the AOC 22 are not likely to migrate a great distance with groundwater, and, as such, do not represent a significant exposure hazard. These conditions could change in the future if the usage of the Site changes, or if domestic or irrigation wells are installed nearby.

1.6. Closed-Loop Bioreactor Pilot Study

Based on the evaluation of remedial alternatives in the AOC 22 Focused Feasability Study (Tetra Tech NUS, Inc., February 2002), a bioremediation technology, closed-loop bioreactor (CLB), was selected for a pilot study at AOC 22. The primary objective of the pilot study is the source removal of petroleum hydrocarbons from the vadose and saturated zones to prevent further leaching of contaminants into groundwater, and the removal of free petroleum product, if it occurs, from the groundwater surface. Dissolved-phase VOCs and SVOCs having concentrations exceeding the remedial action goals will subsequently be removed from the aqueous phase during the remedial process.

The selected pilot study methodology for the AOC 22 unit is CLB process. The CLB process is a combination of technologies, which includes vapor extraction (VE), air sparging (AS), vacuum enhanced product recovery, desorption of hydrocarbons from soil particles, and enhanced bio-degradation. The CLB process creates an in-situ bioreactor in vadose and saturated soils. The process design is a closed-loop system with a continual circulation of air from groundwater sparge points to vadose injection and vacuum extraction wells.

The CLB process uses a system of patented nutrients to accelerate the growth and biodegradation characteristics of existing indigenous bacteria. The process enhances the effectiveness of indigenous bacteria to biodegrade the COCs, **but does not utilize the inoculation of foreign or genetically engineered bacteria to degrade contaminants**. The surfactant, nutrients and supplemental food source are all completely biodegradable. To demonstrate that no breakdown products remain above ambient groundwater conditions, groundwater samples will be analyzed for nitrates/nitrites and surfactants.

At the start of the process, the technology uses a small surface bioreactor to initiate the growth of indigenous bacteria that are capable of destroying petroleum constituents. Within the bioreactor moisture, nutrients, and associated co-metabolites are used to accelerate the growth of the bacteria. Once biogrowth occurs, the vapor-based biomixture is then circulated into the vadose zone through a series of vapor extraction and injection wells, which forms a site-wide closed-loop system. Accordingly, the biomass vapor that is created and injected in the vadose zone is circulated through the subsurface to the appropriate extraction wells, and back to the small surface bioreactor for testing and re-stimulation.

This procedure occurs without any discharge to the atmosphere. Once this process is started, the bioreactor operation continues until an appropriate biomass is established in the vadose zone, which causes the vadose zone itself to act and operate as a larger site-wide bioreactor. This unique situation is maintained during the entire remediation process.

After free product is removed and the vadose zone bioreactor is fully established, groundwater air sparging is initiated. The design of the remedial program includes the installation of dual use air sparging and vapor extraction wells at each sparge point locations. The mechanical sparging action addresses volatile dissolved constituents that are in the groundwater. The air sparging action liberates the volatile petroleum fractions in the groundwater, which then migrate upward into the vadose zone bioreactor, where the constituents are consumed by vapor extraction and biodegradation.

The removal of contaminants from the groundwater is accelerated by bio-stimulation, in a process that is very similar to the biodegradation that occurs in wastewater treatment plants, in a process that further enhances the biodegradation of constituents in the groundwater. Any products that are introduced are also ultimately degraded as bacteria nutrient sources.

The CLB process is maintained and enhanced by an above ground mobile treatment system that includes the surface bioreactor, pump equipment, compressors, and instrumentation (Figure 1-6). The mobile treatment system equipment allows for the adjustment of air circulation rate, moisture control, and nutritional enhancement, which are necessary for a sustained bio-reaction process in the vadose zone.

A critical element of the CLB process is the mobilization of adsorbed chemical constituents. To accomplish this, patented biodegradable surfactants will be injected into the subsurface to enhance the mobilization process. The surfactant substrate is ionic and has the effect of increasing the permeability with respect to hydrocarbons trapped in the soil due to its ionic nature. The surfactant that will be used is completely biodegradable, and is processed from naturally occurring surfactants secreted by bacteria. Pulsing and low-pressure injection is applied so that preferential pathways and fingering of the surfactant through the soil does not occur. The surfactant is injected at a temperature of approximately 35^{o} Celsius (95^{o} Fahrenheit). The high temperature further increases the viscosity of the constituents to approximately that of water and allows the contaminants to become mobile. The mobilized/emulsified product is then transported and drawn into vacuum extraction/recovery wells where it is removed using skimmer pumps. **The removal of the trapped source is the key to the remediation process.** Once the source constituents are eliminated, groundwater cannot be re-contaminated by their presence. Subsequently, engineered biodegradation of dissolved groundwater contaminants can proceed without the problem of recontamination. The result is a linear (vs. asymptotic) contaminant reduction profile that is typical of the CLB process, and is the key element in a rapid cleanup schedule.

Vapor extraction (VE) is an important element of the closed loop process. The extracted vapor train is circulated through the surface bioreactor and is then injected back into the subsurface via groundwater sparge wells and nested vadose zone surfactant injection wells, as applicable. In this manner, the closed loop process does not produce air emissions to the atmosphere; therefore, no effluent destruction equipment or air quality permits will be necessary. Biodegradation is further enhanced by the VE process (via higher aerobic activity), which in turn accelerates both the soil and dissolved groundwater remediation concurrently.

Both No. 4 and No. 6 fuel oil are long-chain (i.e., heavy molecular weight) hydrocarbons. No. 6 fuel oil in particular is a high viscosity fuel oil. Because of its high molecular weight, biodegradation is likely to be slow. Therefore, the CLB process will be enhanced through the use of Fenton's Reagent. Fenton's Reagent is an iron-catalyzed hydrogen peroxide mixture that, when applied to a carbon source, breaks down the carbon compound through oxidation. As the oxidation reaction proceeds, heat

is generated. Through the breaking down of the carbon chain and the creation of heat, the heavy fuel oils will become less viscous, and thus more mobile, in the subsurface.

Locus will implement an air monitoring program during ground intrusive activities, such as well installation, and during the startup of the CLB process, to the extent practicable, with respect to VOCs. The air monitoring program for ground intrusive activities will consist of Locus/ARUSI personnel collecting VOC measurements using a photo-ionization detector or equivalent at downwind location. VOC data will be collected at approximately 15-minute intervals and recorded in the field log. During the startup of the CLB process (the first two days) VOCs will be monitored as previously stated. However, if VOCs are not detected, air monitoring frequency will be reduced gradually according to the following schedule: Hourly day 3 to day 5 and the once daily thereafter.

1.7. Closed-Loop Bioreactor Pilot Study Implementation Schedule

A project schedule has been included in Appendix B. The schedule shows all major tasks as outlined in the scope of work, and activities associated with each tasks. The critical path method (CPM) will be used to schedule and control project related activities using Microsoft Project 2000. The schedule will be updated at monthly intervals. Each invoice submitted to NAVFAC will be accompanied by an updated project schedule that shows the progression of the remedial program.

1.8. Community Relations

Locus Technologies will participate in four (4) Restoration Advisory Board (RAB) meetings with EFANE, with the objective of describing the CLB technology, describing the pilot study approach, and reporting progress.

2. PILOT STUDY DESIGN

2.1. Design Strategy

The overall remedial design was developed by Locus in conjunction with AR Utility Specialists, Inc. (ARUSI). Locus has developed the remedial strategy to address the contaminated soil and groundwater at the AOC 22. ARUSI is responsible for remedial construction design and implementation, and will provide the proprietary biodegradation additives used to enhance the natural biodegradation of contaminants in the subsurface.

2.2. Design Activities

The following is a list of design activities that are required prior to implementation of the remedial program:

- Pre-design meeting/site walk
- Development of this remedial documents which include the Pilot Study Work Plan, Sampling and Analysis Plan, and Health and Safety Plan
- Completion of remedial design drawings, to include remedial well locations, underground piping, and electrical design plans
- Procurement of construction, environmental, and drilling permits where applicable

2.3. Design Deliverables

Prior to implementation of the remedial activities, the following deliverables will be completed:

- Pilot Study Work Plan
- Pilot Study Sampling and Analysis Plan (Appendix C)

- Pilot Study Health and Safety Plan (Appendix D)
- Pilot Study Design Drawings
- Construction and Use permits, if necessary

2.4. Evaluation of Previous Data

Locus reviewed the FA/FFS prepared by Tetra Tech NUS. The FA/FFS included a brief review of the site history, and a detailed discussion of soil and groundwater analytical results from previous investigations conducted in 1997 and 1999. The report identified Applicable or Relevant and Appropriate Requirements (ARARs) in an effort to develop remedial alternatives. Six remedial alternatives were selected for review. Those alternatives are (1) no action; (2) cover and institutional controls; (3) excavation and off-site disposal; (4) bioremediation, institutional controls, and monitoring; (5) in-situ chemical oxidation; (6) thermally enhanced soil vapor extraction. This effort will serve as a pilot test of the remedial alternative Number 4 from the FA/FFS.

The NYSDEC reviewed the FA/FFS and determined that active remediation of the AOC 22 source area soils is necessary to ensure protection of the groundwater beneath the site. The chosen remedial technology (CLB) described in this work plan will fulfill this requirement through the removal of contaminant mass at the source area.

2.5. Design Criteria

The CLB system proposed for this site consists of the remediation well infrastructure, which includes extraction and injection wells connected by lateral piping to the main treatment system; the mobile remedial equipment trailer housing the surface bioreactor and associated equipment; and the electrical power distribution system.

3. PERMITTING REQUIREMENTS

Locus understands that this remedial project is located on a federal facility and that no local permitting is required. However, all well and infrastructure and construction will be in accordance with all applicable regulatory and construction standards. If any permit are required, Locus will obtain them in a timely manner.

4. CONSTRUCTION

4.1. Construction Strategy

Construction of the CLB pilot system will begin with the installation of the remediation wells, the locations of which have been chosen based on previous soil and groundwater analytical results. A licensed drilling contractor will perform all well drilling and installation activities, under the supervision of Locus personnel. Following completion of the well installation phase, a licensed contractor will be retained to install all lateral underground piping, which will connect the remediation wells to the above-ground remedial equipment trailer. Once the lateral piping is in place, a licensed electrician will connect the electrical supply to the remedial system. All infrastructure construction activities will be under the supervision of ARUSI personnel. Local licensed contractors and businesses will be used to the maximum extent practicable to perform infrastructure construction tasks.

4.2. Construction Activities

4.2.1. Health and Safety Plan

Locus has prepared a site-specific Health and Safety Plan (HASP) which is included in Appendix D. The plan will include a description of the hazard assessment including level of safety protection to be used during field operations and exposure monitoring. The plan also addresses overhead and underground utilities and safety during trenching operations, equipment installation, equipment noise levels, heat stress and emergency response procedures. A copy of the HASP will be given to all integrated team partners (ITP) personnel and subcontractors working on the project.

4.2.2. Well Installation

An Locus and/or ARUSI field geologist or engineer will supervise the installation of 34 air sparging and injection/extraction cluster wells. Well locations have been chosen based on the site lithology, occurrence of phase separated hydrocarbons, and the boundaries of the dissolved phase hydrocarbon plume. All 34

wells will be installed on site property. Remediation well locations are included on the Remediation Site Plan (Figure 1-5).

Locus understands that underground utilities exist at AOC 22. The approximate locations of these utilities are as indicated in the electronic figures provided by the client and shown on Figure 1-5. Currently these utilities are shut down, but need to be preserved for future use. To avoid damaging the existing underground utilities, the well locations will be cleared prior to drilling by hand digging with a post-hole digger. The well locations may need to be adjusted during the field activities to avoid possible conflicts.

The remediation wells will be installed using a hollow-stem auger drill rig. Twenty-eight (28) deep-nested wells will be drilled to a depth of approximately 75 feet bgs, and will be constructed of 2-inch- and 4-inch-diameter polyvinylchloride (PVC) well casing and screen. The screened interval for the 2-inch sparge wells will extend from approximately 70 to 75 feet bgs, and will consist of 0.01-inch slotted high-flow screen. The screened interval for the 4-inch-diameter injection/extraction wells will extend from 20 to 65 feet bgs and will consist of 0.02-inch slotted high-flow screen. The proposed well construction diagrams are included on Figure 1-7.

Six shallow vapor extraction wells will be drilled to a depth of approximately 25 feet bgs and will be constructed of 4-inch-diameter PVC well casing and screen. The screened interval will extend from approximately 10 to 25 feet bgs and will consist of 0.02-inch slotted high flow screen. All 34 wellhead completions will be mounted flush to the ground surface within 24-inch-diameter traffic-rated well vaults.

During drilling, soil samples will be collected from selected wells at 10-foot depth intervals. The samples will be collected using a split-spoon sampler (either 18 or 24 inches long) containing 6-inch long brass sleeves. Upon reaching a chosen sampling depth, the sampler will be lowered into the borehole and driven a minimum of 18 inches into undisturbed soil. Upon retrieving the sampler, the brass sleeves will be removed. The lowermost sleeve will be retained for possible laboratory analysis. Soil in the remaining sleeves will be retained for lithologic description. Soil samples that are submitted to an analytical laboratory will be analyzed for TPH using United States Environmental Protection Agency (EPA)

Method 8015, VOCs using EPA Method 8260B and SVOCs using EPA Method 8270C. A detailed description of the sampling methodology is included in the Sampling and Analysis Plan (Appendix C).

4.2.3. Lateral Piping Installation

All injection/extraction wells will be connected to the CLB remedial system using 2-inch- and 4-inch-diameter Schedule 40 PVC piping. Lateral piping will be placed in trenches located greater than 3 feet below grade to avoid freezing conditions. A flow control valve will be installed at each connection of lateral piping and well head. All manifold piping will be routed to a manifold located near the system trailer.

4.2.4. Remedial System Enclosure and Electrical Service

The CLB remedial system and controls will be enclosed on the property within a secured trailer measuring approximately 8 feet by 25 feet. The trailer will be located within the GAC building, with the remaining floor space within the building being utilized as a field office.

ARUSI will supervise the construction of a below-ground electrical distribution line originating from existing electrical switch near the GAC Building. The new supply will be attached to a new electrical panel inside the GAC Building. A licensed electrician will coordinate the installation of the three-phase, 460-volt electrical service in the GAC Building, which will be inspected by the local utility and municipal inspectors, if necessary, prior to system start-up.

4.2.5. Waste Disposal and Transport

Drill cuttings generated during drilling activities will be stored on the property in Department of Transportation (DOT)-approved drums or covered roll-off bins, pending results of soil sample laboratory analyses. After the waste material has been characterized, it will be disposed of in an appropriate manner.

5. POST-CONSTRUCTION

5.1. Baseline Groundwater Sampling

Upon completion of the remedial system infrastructure, and prior to system start-up, a total of eight (8) groundwater samples will be collected from selected remediation wells and the existing monitoring wells. All groundwater samples will be submitted to a NYDEC and NAVFAC EFANE certified laboratory. Depth to groundwater measurements will be collected from the monitoring wells prior to sampling in order to confirm the current groundwater flow direction.

The purpose for the collection and analyses of groundwater samples from monitoring and remediation wells is to screen the groundwater for biological conditions and changes in contaminant concentrations. The results of groundwater sampling events will be compared to the previous sampling events and will be the basis for modifications to the CLB operation.

Groundwater samples will be submitted to the analytical laboratory for analysis of TPH using EPA Method 8015, SVOCs using EPA Method 8270C, VOCs using EPA Method 8260B, Nitrates/nitrites using EPA Method 353.2, and surfactants using EPA Method 425.1. In addition, selected samples will be analyzed for the bacteriological parameters of Petroleum Hydrocarbon Degraders (PHD), Heterotrophic Plate Count (HPC), and Pseudomonads. The biological parameters will be analyzed from a minimum of one well located at the upgradient edge of the contaminant plume, one well from the center of the plume, and one well at the downgradient edge of the plume. A detailed description of the sampling methodology is included in the Sampling and Analysis Plan (Appendix C).

Results from this sampling event will be used to establish a baseline of concentrations for both the contaminants and the native microorganisms that will be used to accelerate the bioremediation process.

5.2. Remedial System Start-up

Once the CLB system is mobilized to the site, injection and extraction well manifolds will be assembled, electrical connections will be completed, and a water supply will be connected. Upon initial start-up, system operation parameters will be inspected for proper operation.

5.3. Remedial System Operation and Maintenance

The initial 90 days of remedial system operation will focus on the removal of free product. Following installation of the remediation wells, a determination will be made as to which wells, if any, will require the installation of product skimmer pumps. It may be necessary to install and remove pumps from individual wells several times during this initial phase of the program. The CLB system will be operated in a closed loop with the aim of mobilizing free product toward the remediation and monitoring wells near the center of the treatment area, where it can be removed by pumping. During the initial phase, the remediation wells on the boundaries of the treatment area will be operated in air sparging mode, with vapor extraction being applied to wells nearer the center of the plume.

A project engineer or technician from ARUSI or Locus will initially be onsite daily during the system operation to monitor injection and extraction rates, add nutrients and surfactant to the system, and perform maintenance and any necessary repairs to system components.

During the course of operation, data will be compiled and analyzed to determine the effectiveness of the CLB system for reducing petroleum hydrocarbon concentrations in the soil and groundwater. Necessary adjustments will be made to the system and the results monitored.

During normal system operation vapors collected from the vacuum side of the CLB are passed through the absorption tank where approximately 80% of the volatile vapors are destroyed. The absorption tank is pressurized to two (2) to four (4) atmospheres causing the VOCs to be adsorbed into the liquid in the in the adsorption tank. The VOC-laden liquid is then circulated through the internal bioreactor where the VOCs are consumed. Oxygen is injected into the internal bioreactor to enhance the reaction rate and to ensure oxygen rich vapor for re-injection into the subsurface.

The remainder of the VOCs that are not destroyed in the absorption tank are re-injected into the subsurface, distributed throughout the subsurface and consumed in the CLB process. Although it highly unlikely that any vapor will be emitted from the CLB process, air monitoring around AOC 22 will be performed periodically to ensure that no vapors are being emitted to the atmosphere. Should vapor emissions be detected, the system will be repaired or operations modified such that no vapors are emitted.

5.4. Pilot Study System Monitoring

To monitor the progress of the remedial program, soil and groundwater samples will be periodically collected. Soil samples will be collected from new soil borings beginning approximately 60 days after starting the system. Groundwater samples will be collected monthly following system startup.

5.4.1. Verification Soil Sampling

Following system start-up, soil samples will be collected from borings on a bi-monthly basis (i.e., during months 2, 4, 6, 8, 10, and 12). Boring locations and sampling depths will be determined based on analytical results from the well installation program. The soil borings will be drilled using a hollow-stem auger drill rig. Samples will be submitted to an analytical laboratory for analysis of TPH using EPA Method 8015, VOCs using EPA 8260B and SVOCs using EPA Method 8270C. Selected soil samples may also be analyzed for the listed biological parameters.

5.4.2. Groundwater Monitoring

The progress of remediation system will also be monitored through the monthly collection of depth to groundwater measurements and groundwater samples. A total of eight (8) groundwater samples will be collected from selected existing monitoring wells and selected remediation wells. Groundwater samples will be submitted to an analytical laboratory for analysis of TPH using EPA Method 8015, SVOCs using EPA Method 8270C, VOCs using EPA Method 8260B, Nitrates/nitrites using EPA Method 353.2 and surfactants using EPA Method 425.1. In addition, selected samples will be analyzed for the bacteriological parameters of Petroleum Hydrocarbon Degraders (PHD) using method SM 9215B or equivalent, and Heterotrophic Plate Count (HPC) using method SM 9215B Modified or equivalent.

5.4.3. Monthly Reporting

During the course of operation, data will be compiled and analyzed to determine the effectiveness of the CLB system to reduce fuel oil No. 4 and No. 6 contaminant concentrations in the soil and groundwater. Adjustments will be made to the system and the results monitored. We have estimated the need to submit monthly (or as required) remediation status reports to NAVFAC and the NYSDEC. The reports will include groundwater sampling analytical data, laboratory analytical quality control and validation reports, depth to groundwater and free product thickness measurements, and a summary of the operational/maintenance activities performed on the system.

6. PILOT STUDY EVALUATION REPORT

At completion of the verification sampling, the project team will prepare a final pilot study evaluation report for submittal to NYSDEC. This report will include a description of equipment and procedures used during the program, as well as laboratory analyses of soil and groundwater samples collected as part of the remediation. The report will also include tables showing baseline hydrocarbon concentrations in the soil and groundwater and the reduction in concentration over time. Upon acceptance of this report, the project team will schedule site restoration and system decommissioning activities.

7. SITE RESTORATION

The physical site condition shall be restored to the same or better condition prior to the start of the remedial program. This effort would include all necessary resurfacing efforts for trenching, remedial wells and vaults. In places where asphalt or surface cover or curbing has been affected, the project team will replace those areas so they conform to their original condition at the start of the program. If planters or any vegetation are disturbed or removed during the remedial effort, they will be restored to their original condition. The project team will also perform all relevant closeout requirements pursuant to project requirements. These services may include document return, file duplication, distribution and storage, file archiving (meeting superfund record requirements).

8. REFERENCES

Halliburton NUS Environmental Services, 1991. Final Remedial Investigation Quality Assuance Plan, Comprehensive Long-Term Environmental Action Navy (CLEAN) Program Naval, Weapons Industrial Reserve Plant, Bethpage, New York, August.

NYSDEC, 1992. Spill Technology and Remedial Series (STARS) Memorandum No. 1 – Petroleum–Contaminated Soil Guidance Policy, August.

NYSDEC, 1994. Division of Technical and Administrative Guidance Memorandum (TAGM) No. 4046, Determination of Soil Clean-up Objectives and Clean-up Levels, January 24.

TtNUS (Tetra Tech NUS, Inc.), 2002. RCRA Facility Assessment/Focused Feasibility Study for Former Underground Storage Tanks Plant No. 3Area of Concern (AOC) 22 (Tank Nos. 03-01-1, -2, and –3), Naval Weapons Industrial Reserve Plant (NWIRP), Bethpage, New York. Prepared for Northern Division Naval Facilities Engineering Command, February.

USEPA (U.S. Environmental Protection Agency) 1997. Test Methods for evaluating Solid Waste Physical/Chemical Methods (SW-846). Third Edition, Update 3, June.

TABLES

TABLE 1. Maximum Groundwater Contaminant Concentrations and Remedial Action Goals
NWIRP Bethpage AOC 22, Bethpage, New York

Chemical	Maximum Concentration (ug/kg)	Remedial Action Goal [1] (ug/kg)
Volatile Organic Compounds		
Benzene	**17.0**	1 [1]
2-Butanone	3.4	50 [2]
Chloroethane	4.4	5 [1,2]
cis-1,2-Dichloroethene	**48.0**	5 [1,2]
1,1-Dichloroethane	4.1	5 [1,2]
1,2-Dichloroethene	**47.0**	5 [1,2]
Ethylbenzene	**18.0**	5 [1,2]
Tetrachloroethene	**12.0**	5 [1,2]
Toluene	1.4	5 [1,2]
Trichloroethene	**95.0**	5 [1,2]
Trichlorofluoroethane	**8.2**	5 [1,2]
Vinyl Chloride	**2.7**	2 [1,2,3]
Total Xylenes	**7.6**	5 [1,2]
Semivolatile Organic Compounds		
Acenaphthene	1.5	50 [2]
Bis(2-ethylhexyl)phthalate	43.0	6 [2,3]
Carbazole	**4.2**	50 [2]
Fluorene	2.1	50 [2]
2-Methylnaphthalene	41.0	50 [2]
Naphthalene	20.0	50 [2]
Phenanthrene	3.6	50 [2]
Total Petroleum Hydrocarbons	NA	NE

Notes:
ug/kg - micrograms per kilogram
bgs - below ground surface
[1] - New York State Groundwater Quality Standard
[2] - New York State Maximum Contaminant Level
[3] - Federal Maximum Contaminant Level
NA - Not Analyzed
NE - Not Established

TABLE 2. Maximum Soil Contaminant Concentrations and Remedial Action Goals
NWIRP Bethpage AOC 22, Bethpage, New York

Chemical	Maximum Concentration (ug/kg)	Remedial Action Goal [1] (ug/kg)
Volatile Organic Compounds		
Acetone	12.0	100
Benzene	**150.0**	60
n-Butylbenzene	270.0	NE
sec-Butylbenzene	210.0	NE
Ethylbenzene	1,500.0	5,500
Isopropylbenzene	210.0	NE
p-Isopropyltoluene	120.0	NE
Methylene Chloride	8.0	93
n-Propylbenzene	610.0	NE
Toluene	6.3	1,500
1,3,5-Trimethylbenzene	500.0	NE
Total Xylenes	84.0	1,200
Semivolatile Organic Compounds		
Acenaphthene	4,100.0	50,000
Anthracene	5,100.0	50,000
Benzo(a)anthracene	**4,300.0**	330
Benzo(a)pyrene	**2,700.0**	330
Benzo(b)fluoranthrene	840.0	1,100
Benzo(g,h,i)perylene	1,500.0	50,000
Benzo(a)fluoranthrene	470.0	1,100
Chrysene	**7,500.0**	400
Dibenz(a,h)anthracene	**450.0**	330
Fluoranthene	4,200.0	50,000
Fluorene	8,600.0	50,000
Indeno(1,2,3-cd)pyrene	360.0	3,200
2-Methylnaphthalene	3,200.0	35,400
Naphthalene	310.0	13,000
Phenanthrene	27,000.0	50,000
Pyrene	32,000.0	50,000
Total Petroleum Hydrocarbons	21,000.0	NE

Notes:
ug/kg - micrograms per kilogram
bgs - below ground surface
[1] - New York State Department of Environmental Conservation Technical and Administrative Guidance Memorandum #4046 recommended clean-up objectives
NE - Not Established

Table 3. Summary of Bottle Requirements, Preservation Methods, and Holding Times
NWIRP Bethpage AOC 22, Bethpage, New York

Analytical Parameter	Analytical Method	Container Type		Sample Preservation	Sample Holding Time
		Soil	Groundwater		
Total Petroleum Hydrocarbons	EPA 8015	Brass Sleeve or Glass Jar	2 - 500 ml Glass Bottles	Soil - Cool 4°C Groundwater - Cool 4°C, HCl	Soil - 7 Days Groundwater - 14 Days
Semivolatile Organic Compounds	EPA 8270C	Brass Sleeve or Glass Jar	2 - 1 L Glass Bottles	Soil - Cool 4°C Groundwater - Cool 4°C	Soil - 7 Days Groundwater - 14 Days
Volatile Organic Compounds	EPA 8260B	Brass Sleeve or Glass Jar	2 - 4- ml VOA's	Soil - Cool 4°C Groundwater - Cool 4°C, HCl	Soil - 14 Days Groundwater - 14 Days
Nitrates/nitrites	EPA 353.2		250 ml HDPE Bottle	Groundwater - Cool 4°C, H_2SO_4	Groundwater - 28 Days
Surfactants	EPA 425.1		500 ml HDPE Bottle	Groundwater - Cool 4°C	Groundwater - 2 Days
Heterotropic Plate Counts	SM 9215B or Equivalent	Brass Sleeve or Glass Jar	1 - 500 ml HDPE Bottle	Soil - Cool 4°C Groundwater - Cool 4°C	Soil - 3 Days Groundwater - 3 Days
Petroleum Hydorcarbon Degraders	SM 9215B Modified or Equivalent	Brass Sleeve or Glass Jar	1 - 500 ml HDPE Bottle	Soil - Cool 4°C Groundwater - Cool 4°C	Soil - 3 Days Groundwater - 3 Days

FIGURES

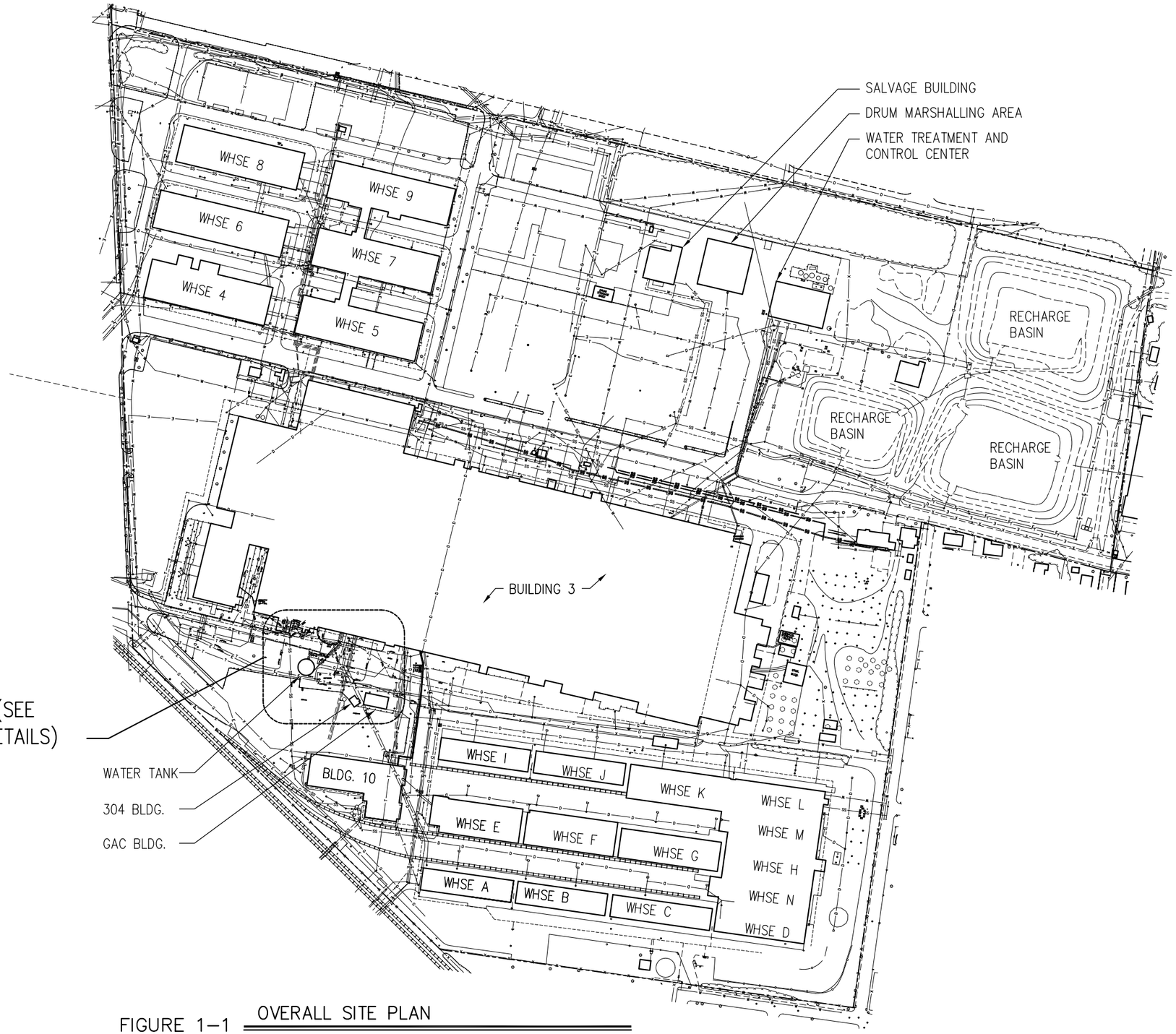

FIGURE 1-1 OVERALL SITE PLAN

SCALE: NONE

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PROJECT DESCRIPTION

CLOSED-LOOP BIOREMEDIATION PILOT DEMONSTRATION PLANT 3, AREA OF CONCERN 22

999 S. OYSTER BAY RD.
BETHPAGE, NY 11714

REVISIONS

NO.	DATE	DESCRIPTION	BY
A	5/13/04	ISSUED FOR SUBMITAL	JE

PROJECT NO:	N62472-04-C-XXX
DRAWN BY:	JERRY E.
CHECKED BY:	DAN L.
CAD DWG FILE:	N62472-04-C-XXX

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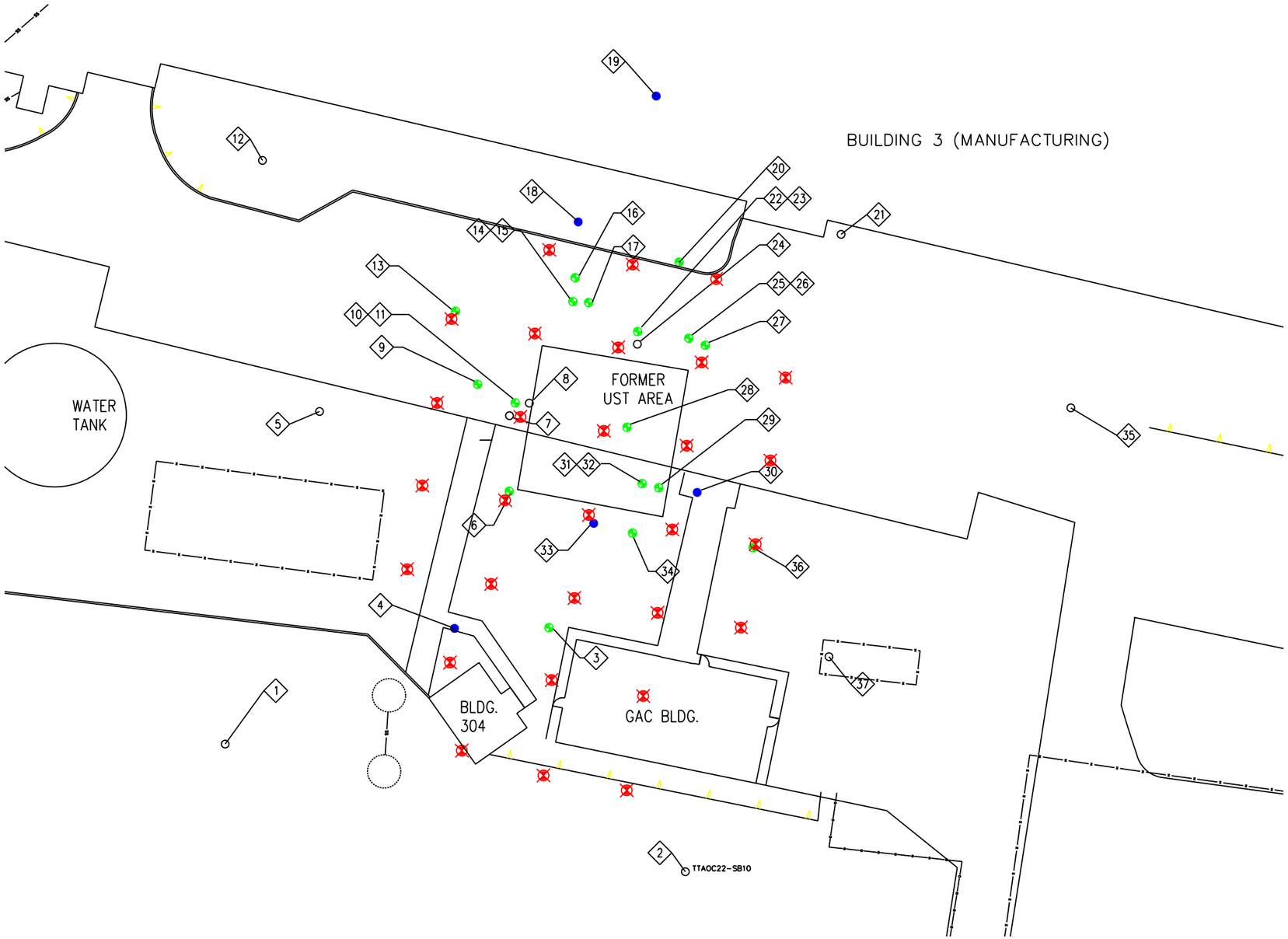
SHEET TITLE

OVERALL SITE PLAN

FIGURE 1-1

SHEET 1 OF 7



LEGEND

- TTNUS SOIL BORING SAMPLE LOCATIONS
- TTNUS SOIL BORING/MONITORING WELL SAMPLE LOCATIONS
- NORTHROP GRUMMAN SOIL BORING SAMPLE LOCATIONS
- PROPOSED PILOT STUDY WELLS

NORTH

0 8' 16' 32'

SCALE: 1/16"=1'-0"

FIGURE 1-2 AREA OF CONCERN (AOC) 22 SITE PLAN & SOIL SAMPLE LOCATIONS

SCALE: 1"=20'-0"

NOTE:
ALL DATA FROM "RCRA FACILITY ASSESSMENT/ FOCUS FEASIBILITY STUDY FOR FORMER UNDERGROUND STORAGE TANKS, PLANT NO. 3 AREA OF CONCERN (AOC) 22" FEBRUARY 2002. TETRA TECH NUS, INC.

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PILOT DEMONSTRATION
PLANT 3, AREA OF CONCERN 22

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NO.	DATE	DESCRIPTION	BY
A	5/13/04	ISSUED FOR SUBMITAL	JE

PROJECT NO: N62472-04-C-XXX
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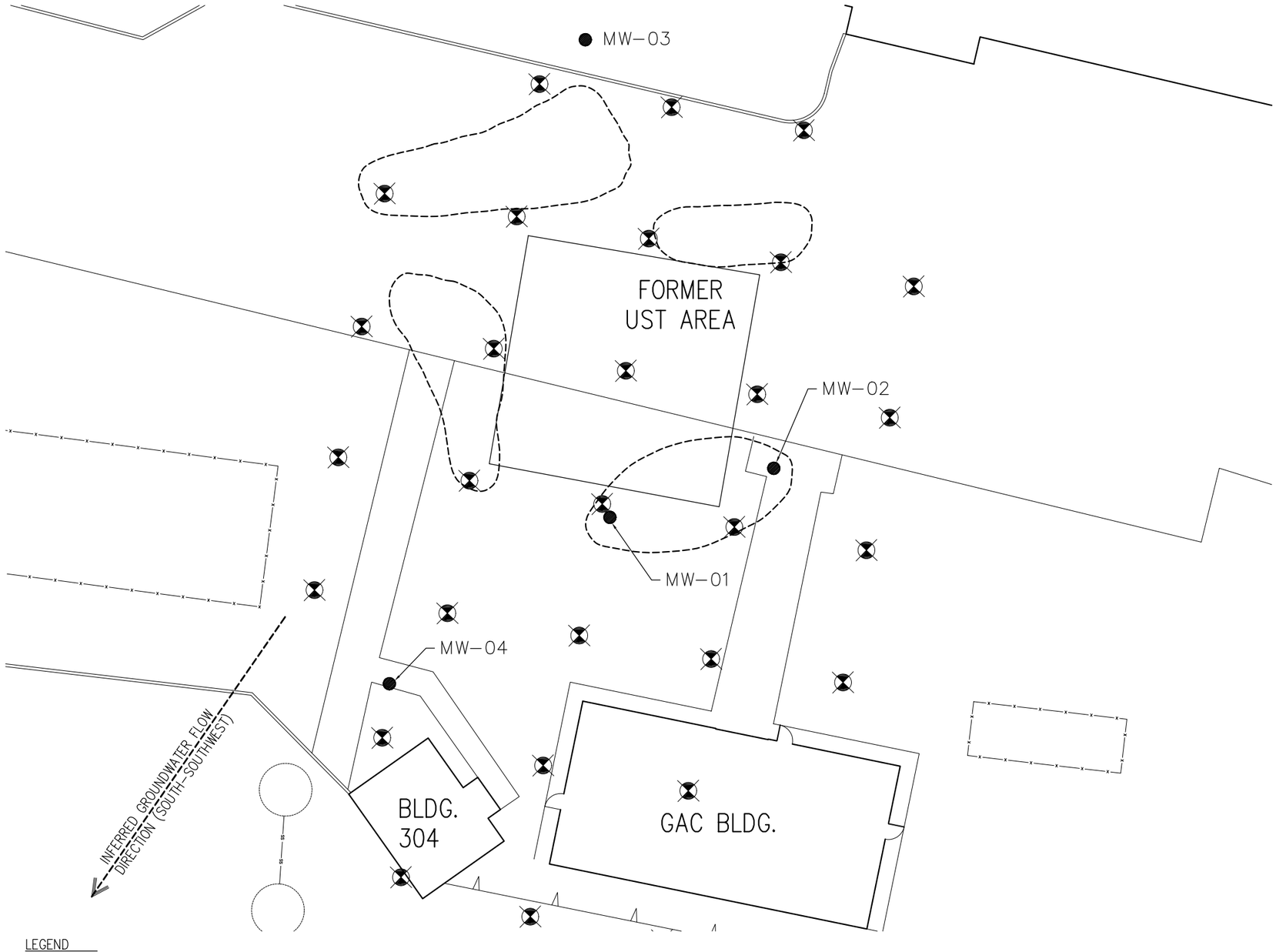
SHEET TITLE
SOIL ANALYTICAL RESULTS

FIGURE 1-2
SHEET 2 OF 7

Jul 06, 2004 - 11:10am - gilbertc - X:\F. Architectural CAD\B. Drawings\Environmental\New York\Bethpage\a-Pre Design\pdf FIGURES\FIGURE 1-2.dwg



LEGEND

MW-# TTNUS SOIL MONITORING WELL LOCATIONS

PROPOSED PILOT STUDY WELLS

TTNUS ESTIMATED LIMITS OR IMPACTED SOIL

INFERRED GROUNDWATER FLOW DIRECTION (SOUTH-SOUTHWEST)
(FA/FFA, TtNUS INC., FEB. 2002)

NORTH

FIGURE 1-3 MONITORING WELL LOCATIONS AND REMEDIATION

SCALE: NONE

NOTE:
ALL DATA FROM "RCRA FACILITY ASSESSMENT/ FOCUS FEASIBILITY STUDY FOR FORMER UNDERGROUND STORAGE TANKS, PLANT NO. 3 AREA OF CONCERN (AOC) 22" FEBRUARY 2002. TETRA TECH NUS, INC.

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NO.	DATE	DESCRIPTION	BY
A	3/26/04	ISSUED FOR SUBMITAL	JE

PROJECT NO: N47408-04-C-7505
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SHEET TITLE
SOIL ANALYTICAL RESULTS

FIGURE 1-3
SHEET 3 OF 7

Jul 08, 2004 - 11:15am - gilbertc - X:\F. Architectual CAD\B. Drawings\Environmental\New York\Bethpage\a-Pre Design\pdf FIGURES\FIGURE 1-3.dwg

KEY NOTES:

1

BOREHOLE: SB-11

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
53–55	N/A	ND	X = 0'–0" Y = 0'–0"

2

BOREHOLE: SB-10

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
55–57	N/A	12	X = 135'–10" Y = –37'–8"

3

BOREHOLE: 16

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
0–8 8–26 26–42 42–54 54–67	NA ND L 1.2–1.9 L 1.0–2.2 L 3,810–89,520*	NA ND–17 L ND L NA 540–19,000	X = 95'–7" Y = 34'–4"

4

BOREHOLE: SB-07

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
55–57	N/A	1,300	X = 67'–8" Y = 34'–2"

5

BOREHOLE: SB-09

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
55–57	N/A	ND	X = 27'–10" Y = 98'–2"

6

BOREHOLE: 01BS

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14 14–16 16–18 18–20 20–22 22–24 24–26 28–30 30–32 32–34 34–36 36–38 38–40 40–42 45–46.5 50–51.5 55–57 60–62 65–67	1.9 1091.2* 4600* N/A 3800* N/A 960* 3080* N/A 530 2250* N/A N/A N/A N/A N/A 2090* 7140* 28969* 58610* 4770	630 500 2800 49 2300 520 J 1400 J 1300 J 620 J 2900 J 3900 J 1600 J 4100 J 1400 J 2500 J 5500 J 1800 J 3600 J 5900 J 18000 J 2800 J	X = 83'–10" Y = 74'–7"

7

BOREHOLE: SB03

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
55–57	N/A	13000	X = 83'–11" Y = 96'–11"

8

BOREHOLE: SB01B

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
NO DATA AVAILABLE			

9

BOREHOLE: 01BW

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14 14–16 16–18 18–20 20–22 22–24 24–26	341.1 N/A 610* 3600* 680* 1130* 1620* 159 N/A	510 N/A 1000 6800 2700 1200 5800 260 27	X = 74'–6" Y = 106'–2"

10

BOREHOLE: 01

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
18–20	N/A	4800	X = 85'–7" Y = 100'–8"

11

BOREHOLE: 01A

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14	1620 N/A N/A	N/A N/A N/A	X = 85'–7" Y = 100'–8"

12

BOREHOLE: SB-13

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
	N/A	ND	X = 11'–0" Y = 172'–3"

13

BOREHOLE: 2BW

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14 14–16 16–18 18–20 20–22	N/A N/A N/A 2060 830* 310 N/A	4.6 2200 7 870 550 310 N/A	X = 68'–0" Y = 127'–9"

14

BOREHOLE: 02A

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12	N/A N/A	N/A N/A	X = 102'–7" Y = 130'–7"

15

BOREHOLE: 02

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
14–16	N/A	2500	X = 102'–7" Y = 130'–7"

16

BOREHOLE: 02BN

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14 14–16 16–18 18–20 20–22	N/A N/A N/A N/A 451.2* N/A 370*	4.6 N/A 630 130 9.2 430 1400	X = 103'–4" Y = 137'–8"

17

BOREHOLE: 02B

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 14–16 16–18 18–20 20–22 22–24 24–26 26–28 28–30 30–32 32–34 34–36 36–38	N/A 870* 4510* 280 87* 400* 530* 2400* 19600* 10060* 480 9890* 4070* 6970*	7.5 490 10000 300 450 220 550 2200 7100 5100 330 6400 2400 3900	X = 107'–3" Y = 130'–3"

18

BOREHOLE: SB-05

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
55–59	7,480*	5,400	X = 104'–2" Y = 154'–1"

19

BOREHOLE: SB-12

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
58–60	N/A	99	X = 127'–3" Y = 191'–3"

20

BOREHOLE: 17

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
0–8 8–26 26–42 42–54 54–67	NA ND–3.1 L ND–2 L ND–1,320* L ND–17,800*	NA ND–11 L ND L ND–980 L 32–6,400	X = 134'–0" Y = 142'–3"

21

BOREHOLE: SB-05

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
55–57	N/A	ND	X = 181'–9" Y = 150'–5"

22

BOREHOLE: 03

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
16–18	N/A	11000	X = 121'–9" Y = 121'–9"

23

BOREHOLE: 03A

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14	N/A 5882* 71.1	N/A N/A N/A	X = 121'–9" Y = 121'–9"

24

BOREHOLE: 02

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
57–59	N/A	21000	X = 121'–8" Y = 118'–0"

25

BOREHOLE: 04

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
14–16	N/A	330	X = 136'–10" Y = 119'–9"

26

BOREHOLE: 04A

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14	637.2 N/A 253	N/A N/A N/A	X = 136'–10" Y = 119'–9"

27

BOREHOLE: 04B

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14	1316* N/A NA	N/A N/A 2900	X = 141'–8" Y = 117'–8"

28

BOREHOLE: 06 AND 06A

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
0–6 6–12 14–16 16–67	NA ND ND NA	NA NA NA NA	X = 118'–7" Y = 93'–6"

29

BOREHOLE: 05B

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
NO DATA AVAILABLE			

30

BOREHOLE: SB04

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
55–57	N/A	12000	X = 139'–4" Y = 74'–3"

31

BOREHOLE: 05

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
14–16	N/A	73	X = 123'–1" Y = 76'–10"

32

BOREHOLE: 06 AND 05A

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
6–8 8–10 10–12	N/A 2.8 2063*	N/A NA NA	X = 123'–1" Y = 76'–10"

33

BOREHOLE: SB01

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
54–56	3000	1900	X = 108'–9" Y = 65'–2"

34

BOREHOLE: 05BS

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
8–10 10–12 12–14 16–18 18–20 20–22 22–24 24–26 26–28 28–30 30–32 32–34 34–36 36–38 38–40 40–42 42–44 44–46	669* N/A 1532* N/A 3600* N/A 1200* 450* N/A N/A N/A N/A N/A N/A N/A 590 630* 752*	86 5.7 18 37 4100 3300 5300 2000 580 1700 720 800 2000 4500 620 1600 770 2300	X = 120'–3" Y = 62'–3"

35

BOREHOLE: SB-14

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
57–59	N/A	2.8	X = 249'–7" Y = 99'–3"

36

BOREHOLE: 15

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
0–8 8–26 26–42 42–54 54–67	NA ND L ND–41 L ND L 4,434–47,344*	NA ND–53 L 4–12 L 22–680 L 1,000–14,000	X = 155'–10" Y = 57'–11"

37

BOREHOLE: SB-08

DEPTH INTERVAL FEET BGS	TOTAL PAHs UG/KG	TPH MG/KG	COORDINATES
55–57	NO	ND	X = 178'–3" Y = 25'–9"

LEGEND:

1. TPH= TOTAL PETROLEUM HYDROCARBONS
2. PAHs = POLYAROMATIC HYDROCARBONS
3. NA = ANALYTE NOT ANALIZED
4. N/A = ANALYTE WAS NOT DETECTED

* = EXCEEDS TECHNICAL AND ADMINISTRATIVE GUIDANCE MEMORANDUM (TAGM) SOIL CLEANUP OBJECTIVE CRITERIA (NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATIVE (NYSDEC) JANUARY 24, 1994 REVISED)

FIGURE 1–4 SOIL ANALYTICAL RESULTS

SCALE: NONE

NOTE:
ALL DATA FROM "RCRA FACILITY ASSESSMENT/ FOCUS FEASIBILITY STUDY FOR FORMER UNDERGROUND STORAGE TANKS, PLANT NO. 3 AREA OF CONCERN (AOC) 22" FEBRUARY 2002. TETRA TECH NUS, INC.

ARUSI
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PROJECT DESCRIPTION

CLOSED–LOOP BIOREMEDIATION PILOT DEMONSTRATION PLANT 3, AREA OF CONCERN 22

999 S. OYSTER BAY RD.
BETHPAGE, NY 11714

REVISIONS

NO.	DATE	DESCRIPTION	BY
A	5/13/04	ISSUED FOR SUBMITAL	JE

PROJECT NO: N62472–04–C–XXX
DRAWN BY: JERRY E
CHECKED BY: DAN L.
CAD DWG FILE:1C04BP0001–A4.0
SIZE "D" IF SHEET IS LESS THAN "22x36" IT IS A REDUCED PRINT. SCALE REQUIRED REDUCED ACCORDINGLY

SHEET TITLE

SOIL ANALYTICAL RESULTS

FIGURE 1–4

SHEET 4 OF 7

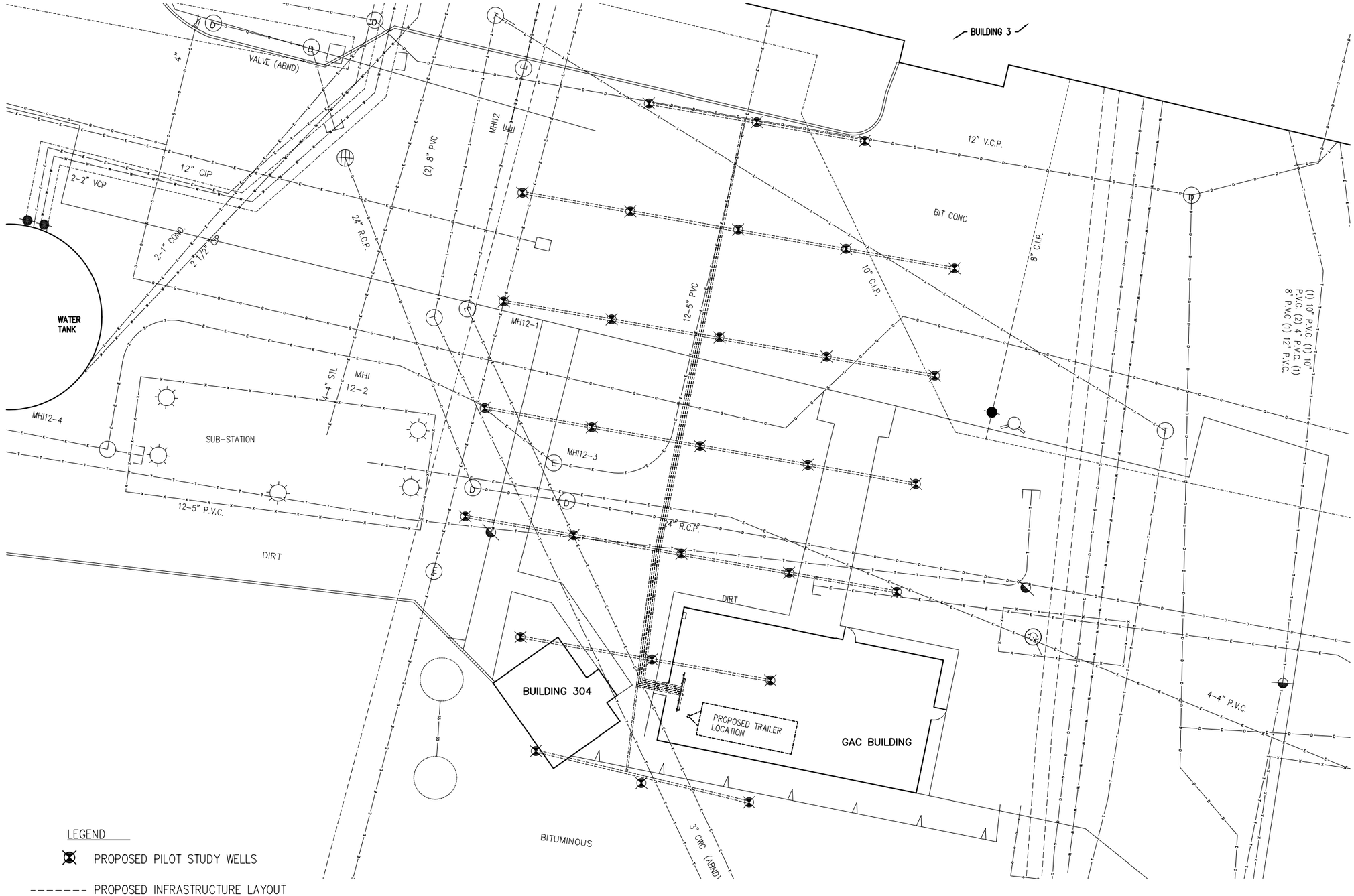

FIGURE 1-5 REMEDIAL SITE PLAN

SCALE: 3/32"=1'-0"

Jul 08, 2004 - 11:16am - gilbertc - X:\F. Architectual CAD\B. Drawings\Environmental\New York\Bethpage\a-Pre Design\pdf FIGURES\FIGURE 1-5.dwg

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PROJECT DESCRIPTION

CLOSED-LOOP
BIOREMEDIATION
PILOT DEMONSTRATION
PLANT 3, AREA OF
CONCERN 22

999 S. OYSTER BAY RD.
BETHPAGE, NY 11714

REVISIONS

NO.	DATE	DESCRIPTION	BY
A	5/13/04	ISSUED FOR SUBMITAL	JE

PROJECT NO:	N62472-04-C-XXX
DRAWN BY:	JERRY E
CHECKED BY:	DAN L.
CAD DWG FILE:	DRAWING NUMBER

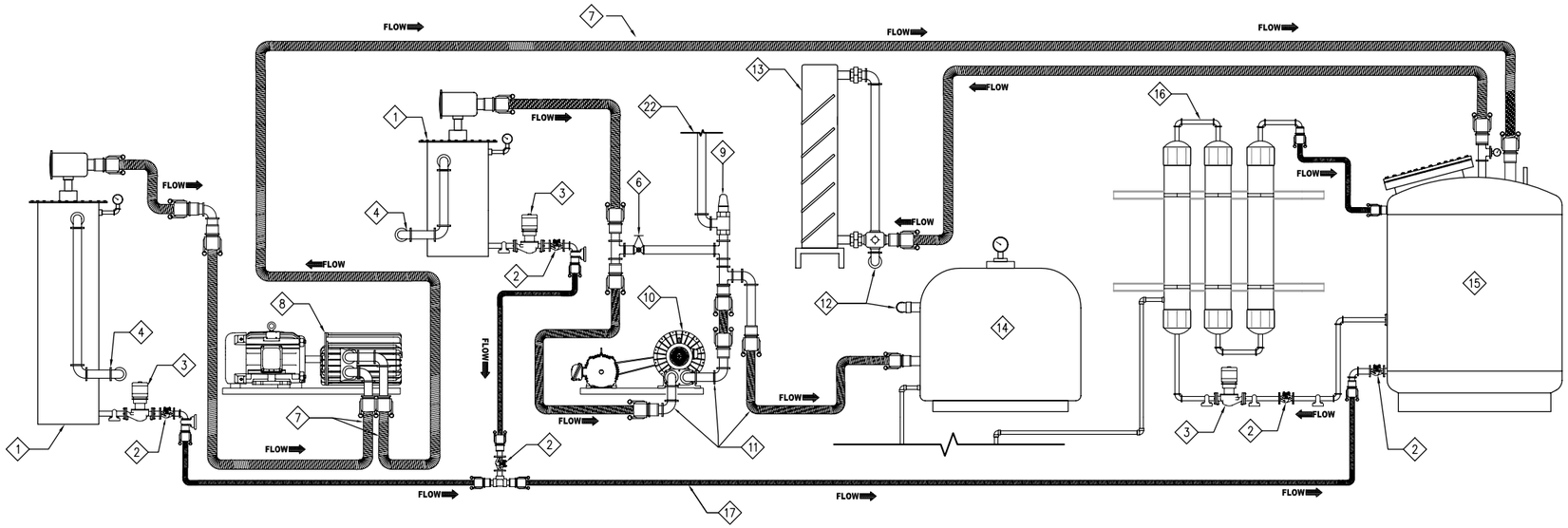
SIZE "D" IF SHEET IS LESS THAN "22x36" IT IS A REDUCED PRINT. SCALE REQUIRED REDUCED ACCORDINGLY

SHEET TITLE

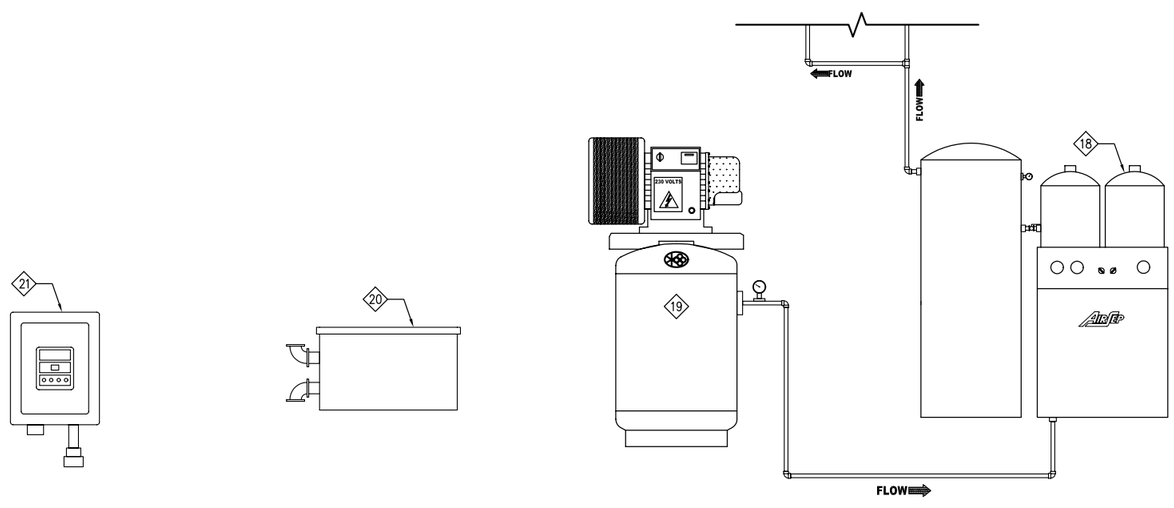
ENLARGED SITE PLAN

FIGURE 1-5

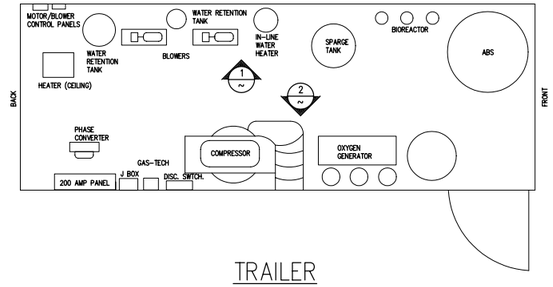
SHEET 5 OF 7



1 DETAIL
SCALE: N.T.S.



2 DETAIL
SCALE: N.T.S.



TRAILER

KEY NOTES:

1. WATER RETENTION TANK
2. CHECK VALVE
3. RECIRCULATING PUMP
4. FROM EXTRACTION LINE
5. CAM OPERATED COUPLING (QUICK DISCONNECT) TYP.
6. FLOW RECIRCULATION VALVE
7. 3" HOSE LINE
8. 30 HP BLOWER ASSEMBLY (ABS)
9. PRESSURE RELEASE VALVE
10. 15 HP BLOWER ASSEMBLY (SPARGE)
11. 2" HOSE LINES
12. TO INJECTION LINE
13. INLINE HEATER
14. SPARGE TANK
15. ABS TANK
16. BIOREACTOR
17. DRAIN TO ABS TANK HOSE LINE. MATCH TO PUMP SIZE
18. OXYGEN GENERATOR
19. AIR COMPRESSOR
20. PHASE CONVERTER 1ø TO 3ø
21. GAS-TECH MONITORING SYSTEM
22. EXIT THROUGH CEILING

FIGURE 1-6 PROCESS FLOW DIAGRAM
SCALE: N.T.S.

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PROJECT DESCRIPTION
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999 S. OYSTER BAY RD.
BETHPAGE, NY 11714

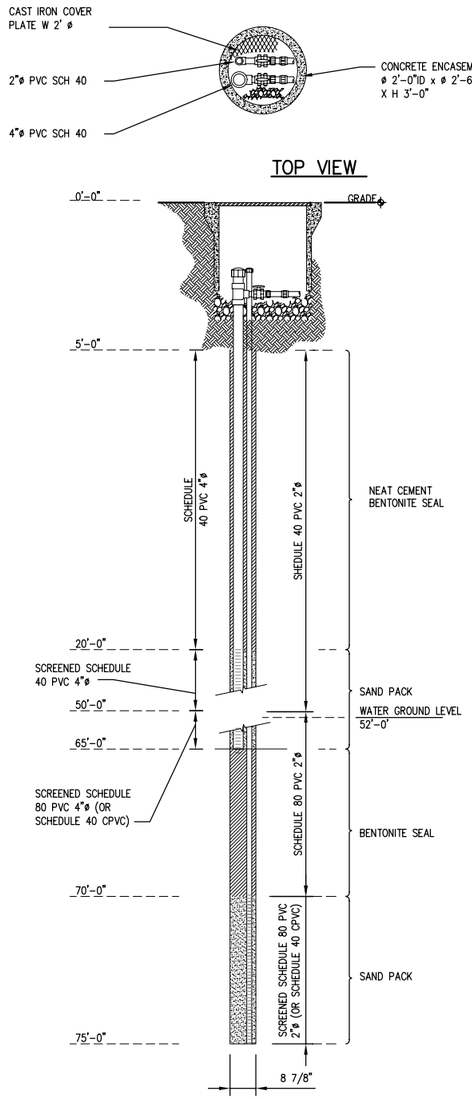
REVISIONS

NO.	DATE	DESCRIPTION	BY
A	5/13/04	ISSUED FOR SUBMITAL	JE

PROJECT NO: N62472-04-C-XXX
DRAWN BY: GILBERT
CHECKED BY:
CAD DWG FILE:DRAWING NUMBER
SIZE "D" IF SHEET IS LESS THAN "22x36" IT IS A REDUCED PRINT. SCALE REQUIRED REDUCED ACCORDINGLY

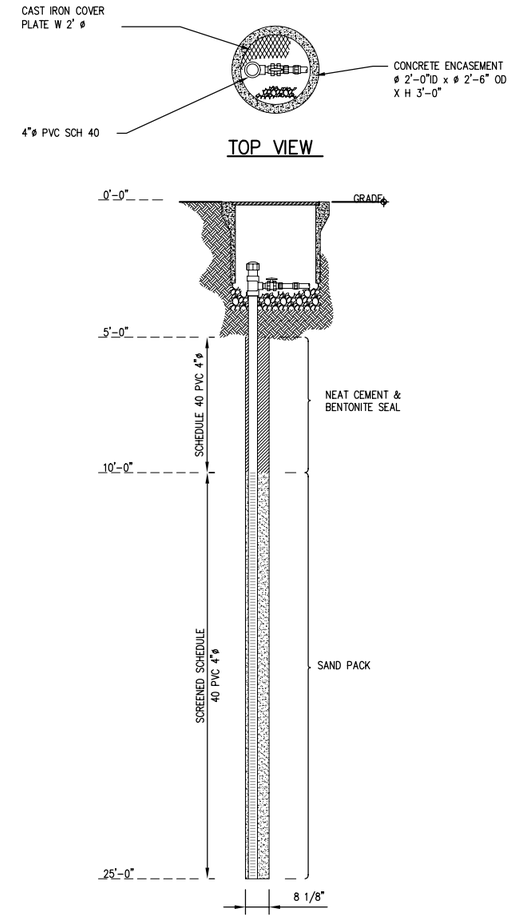
SHEET TITLE
PROCESS FLOW DIAGRAM

FIGURE 1-6
SHEET 6 OF 7



ELEVATION

PILOT STUDY WELL



ELEVATION

SHALLOW PILOT STUDY WELL

FIGURE 1-7 PILOT STUDY WELLS CONSTRUCTION DIAGRAM

SCALE: 3/32"=1'-0"

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PROJECT DESCRIPTION

CLOSED-LOOP BIOREMEDIATION PILOT DEMONSTRATION PLANT 3, AREA OF CONCERN 22

999 S. OYSTER BAY RD.
BETHPAGE, NY 11714

REVISIONS

NO.	DATE	DESCRIPTION	BY
A	3/26/04	ISSUED FOR SUBMITAL	JE

PROJECT NO: N47408-04-C-7505
DRAWN BY: GILBERT C.
CHECKED BY: DAN L.
CAD DWG FILE:1C04BP0001-A6.0
SIZE "D" IF SHEET IS LESS THAN "22x36" IT IS A REDUCED PRINT. SCALE REQUIRED REDUCED ACCORDINGLY

SHEET TITLE

CONSTRUCTION DETAILS

FIGURE 1-7

SHEET 7 OF 7

APPENDIX A

COMPLETE LIST OF AOC 22 GROUNDWATER AND SOIL ANALYTICAL RESULTS

Beth Page
AOC 22
Summary of Analytical Results
Groundwater VOCs/SVOCs

matrix	GW	GW	GW	GW	GW	GW
nsample	TTNUS-22-MW-01	TTNUS-22-MW-02	TTNUS-22-MW-03	TTNUS-22-MW-03-D	TTNUS-22-MW-04	TTNUS-22-MW-05
sample	TTNUS-22-MW-01	TTNUS-22-MW-02	TTNUS-22-MW-03	TTNUS-22-MW-DUP-01	TTNUS-22-MW-04	TTNUS-22-MW-05
sacode	NORMAL	NORMAL	DUP	DUP	NORMAL	NORMAL
sample_dat	12-Aug-99	13-Aug-99	12-Aug-99	12-Aug-99	12-Aug-99	12-Aug-99
cto_proj	283	283	283	283	283	283
proj_manag	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.
Volatile Organics (ug/L)						
1,1,1-TRICHLOROETHANE	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2,2-TETRACHLOROETHANE	5 U	5 U	5 U	5 U	5 U	5 U
1,1,2-TRICHLOROETHANE	5 U	5 U	5 U	5 U	5 U	5 U
1,1-DICHLOROETHANE	4.1 J	3.1 J	2.1 J	2.1 J	2 J	2.6 J
1,1-DICHLOROETHENE	5 U	5 U	5 U	5 U	5 U	5 U
1,2,3-TRICHLOROPROPANE	5 U	5 U	5 U	5 U	5 U	5 U
1,2-DICHLOROETHANE	5 U	5 U	5 U	5 U	5 U	5 U
1,2-DICHLOROETHENE (TOTAL)	7.9	47	11	11	2.9 J	25
1,2-DICHLOROPROPANE	5 U	5 U	5 U	5 U	5 U	5 U
2-BUTANONE	20 U	3.4 J	20 U	20 U	20 U	20 U
2-HEXANONE	20 U	20 U	20 U	20 U	20 U	20 U
4-METHYL-2-PENTANONE	20 U	20 U	20 U	20 U	20 U	20 U
ACETONE	20 U	20 U	20 U	20 U	20 U	20 U
BENZENE	17	12	5 U	5 U	4.1 J	5 U
BROMODICHLOROMETHANE	5 U	5 U	5 U	5 U	5 U	5 U
BROMOFORM	5 U	5 U	5 U	5 U	5 U	5 U
BROMOMETHANE	10 U	10 U	10 U	10 U	10 U	10 U
CARBON DISULFIDE	5 U	5 U	5 U	5 U	5 U	5 U
CARBON TETRACHLORIDE	5 U	5 U	5 U	5 U	5 U	5 U
CHLOROBENZENE	5 U	5 U	5 U	5 U	5 U	5 U
CHLOROETHANE	10 U	4.4 J	10 U	10 U	10 U	10 U
CHLOROFORM	5 U	5 U	5 U	5 U	5 U	5 U
CHLOROMETHANE	10 U	10 U	10 U	10 U	10 U	10 U
CIS-1,2-DICHLOROETHENE	7.9	48	11	12	2.9	25
CIS-1,3-DICHLOROPROPENE	5 U	5 U	5 U	5 U	5 U	5 U
DIBROMOCHLOROMETHANE	5 U	5 U	5 U	5 U	5 U	5 U
ETHYLBENZENE	18	11	5 U	5 U	5 U	5 U
METHYLENE CHLORIDE	5 U	5 U	5 U	5 U	5 U	5 U
STYRENE	5 U	5 U	5 U	5 U	5 U	5 U
TETRACHLOROETHENE	2.7 J	1.5 J	6	5.8	2 J	12
TOLUENE	1.4 J	1.1 J	5 U	5 U	5 U	5 U
TRANS-1,2-DICHLOROETHENE	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
TRANS-1,3-DICHLOROPROPENE	5 U	5 U	5 U	5 U	5 U	5 U
TRICHLOROETHENE	25	67	95	95	17	86
TRICHLOROTRIFLUOROETHANE	5 U	8.2	5 U	5 U	5 U	5 U
VINYL CHLORIDE	2.9 J	27	10 U	10 U	10 U	10 U
XYLENES, TOTAL	7.6	4.7 J	5 U	5 U	5 U	5 U
Semivolatile Organics (ug/L)						
1,2,4-TRICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U
1,2-DICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U
1,3-DICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U
1,4-DICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U
2,2'-OXYBIS(1-CHLOROPROPANE)	10 U	10 U	10 U	10 U	10 U	10 U
2,4,5-TRICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U
2,4,6-TRICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U
2,4-DICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U
2,4-DIMETHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U
2,4-DINITROPHENOL	50 U	50 U	50 U	50 U	50 U	50 U
2,4-DINITROTOLUENE	10 U	10 U	10 U	10 U	10 U	10 U
2,6-DINITROTOLUENE	10 U	10 U	10 U	10 U	10 U	10 U
2-CHLORONAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U
2-CHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U
2-METHYLNAPHTHALENE	41	34	1.9 J	2 J	2.4 J	10 U
2-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U
2-NITROANILINE	50 U	50 U	50 U	50 U	50 U	50 U
2-NITROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U
3&4-METHYLPHENOL	20 U	20 U	20 U	20 U	20 U	20 U
3,3'-DICHLOROBENZIDINE	50 U	50 U	50 U	50 U	50 U	50 U
3-NITROANILINE	50 U	50 U	50 U	50 U	50 U	50 U
4,6-DINITRO-2-METHYLPHENOL	50 U	50 U	50 U	50 U	50 U	50 U
4-BROMOPHENYL PHENYL ETHER	10 U	10 U	10 U	10 U	10 U	10 U
4-CHLORO-3-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U
4-CHLOROANILINE	10 U	10 U	10 U	10 U	10 U	10 U
4-CHLOROPHENYL PHENYL ETHER	10 U	10 U	10 U	10 U	10 U	10 U
4-NITROANILINE	50 U	50 U	50 U	50 U	50 U	50 U

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from gw22_res.dbf
from gw22_res.xls

Beth Page
AOC 22
Summary of Analytical Results
Groundwater VOCs/SVOCs

matrix	GW	GW	GW	GW	GW	GW
nsample	TTNUS-22-MW-01	TTNUS-22-MW-02	TTNUS-22-MW-03	TTNUS-22-MW-03-D	TTNUS-22-MW-04	TTNUS-22-MW-05
sample	TTNUS-22-MW-01	TTNUS-22-MW-02	TTNUS-22-MW-03	TTNUS-22-MW-DUP-01	TTNUS-22-MW-04	TTNUS-22-MW-05
sacode	NORMAL	NORMAL	DUP	DUP	NORMAL	NORMAL
sample_dat	12-Aug-99	13-Aug-99	12-Aug-99	12-Aug-99	12-Aug-99	12-Aug-99
cto_proj	283	283	283	283	283	283
proj_manag	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.
4-NITROPHENOL	50 U	50 U	50 U	50 U	50 U	50 U
ACENAPHTHENE	**1.5 J**	**1.5 J**	10 U	10 U	10 U	10 U
ACENAPHTHYLENE	10 U	10 U	10 U	10 U	10 U	10 U
ANILINE	10 U	10 U	10 U	10 U	10 U	10 U
ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(A)ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(A)PYRENE	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(B)FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(G,H,I)PERYLENE	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(K)FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U
BENZOIC ACID	50 U	50 U	50 U	50 U	50 U	50 U
BIS(2-CHLOROETHOXY)METHANE	10 U	10 U	10 U	10 U	10 U	10 U
BIS(2-CHLOROETHYL)ETHER	10 U	10 U	10 U	10 U	10 U	10 U
BIS(2-ETHYLHEXYL)PHTHALATE	**3.5 J**	**7.7 J**	**13**	**16**	**7 J**	**43**
BUTYLBENZYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U
CARBAZOLE	**4.2 J**	**2.6 J**	10 U	10 U	**1.8 J**	10 U
CHRYSENE	10 U	10 U	10 U	10 U	10 U	10 U
DI-N-BUTYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U
DI-N-OCTYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U
DIBENZO(A,H)ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U
DIBENZOFURAN	10 U	10 U	10 U	10 U	10 U	10 U
DIETHYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U
DIMETHYL PHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U
FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U
FLUORENE	**2.1 J**	**2 J**	10 U	10 U	10 U	10 U
HEXACHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U
HEXACHLOROBUTADIENE	10 U	10 U	10 U	10 U	10 U	10 U
HEXACHLOROCYCLOPENTADIENE	50 U	50 U	50 U	50 U	50 U	50 U
HEXACHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U
INDENO(1,2,3-CD)PYRENE	10 U	10 U	10 U	10 U	10 U	10 U
ISOPHORONE	10 U	10 U	10 U	10 U	10 U	10 U
N-NITROSO-DI-N-PROPYLAMINE	10 U	10 U	10 U	10 U	10 U	10 U
N-NITROSODIPHENYLAMINE	10 U	10 U	10 U	10 U	10 U	10 U
NAPHTHALENE	**20**	**20**	10 U	10 U	**2.5 J**	10 U
NITROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U
PENTACHLOROPHENOL	50 U	50 U	50 U	50 U	50 U	50 U
PHENANTHRENE	**3.6 J**	**3.1 J**	10 U	10 U	10 U	10 U
PHENOL	10 U	10 U	10 U	10 U	10 U	10 U
PYRENE	10 U	10 U	10 U	10 U	10 U	10 U

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from gw22_res.dbf
from gw22_res.xls

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AOC 22
Summary of Analytic Results
Subsurface Soils

nsample	TTNUS-22-SB-01-5456	TTNUS-22-SB-02-5759	TTNUS-22-SB-03-5557	TTNUS-22-SB-04-5759	TTNUS-22-SB-05-5559	TTNUS-22-SB-05-9599	TTNUS-22-SB-06-5557	TTNUS-22-SB-07-5557
sample	TTNUS-22-SB-01-5456	TTNUS-22-SB-02-5759	TTNUS-22-SB-03-5557	TTNUS-22-SB-04-5759	TTNUS-22-SB-05-5559	TTNUS-22-SB-05-9599	TTNUS-22-SB-06-5557	TTNUS-22-SB-07-5557
sample_dat	03-Jun-99	07-Jun-99	08-Jun-99	09-Jun-99	22-Jun-99	22-Jun-99	23-Jun-99	24-Jun-99
coll_metho	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
cto_proj	283	283	283	283	283	283	283	283
proj_manag	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.
Volatile Organics (ug/kg)								
1,1,1-TRICHLOROETHANE	350 U				5.1 U	260 U		
1,1,2,2-TETRACHLOROETHANE	350 U				5.1 U	260 U		
1,1,2-TRICHLOROETHANE	350 U				5.1 U	260 U		
1,1-DICHLOROETHANE	350 U				5.1 U	260 U		
1,1-DICHLOROETHENE	350 U				5.1 U	260 U		
1,2,3-TRICHLOROPROPANE	350 U				5.1 U	260 U		
1,2-DICHLOROETHANE	350 U				5.1 U	260 U		
1,2-DICHLOROETHENE (TOTAL)	350 U				5.1 U	260 U		
1,2-DICHLOROPROPANE	350 U				5.1 U	260 U		
2-BUTANONE	1400 U				20 U	1000 U		
2-HEXANONE	1400 U				20 U	1000 U		
4-METHYL-2-PENTANONE	1400 U				20 U	1000 U		
ACETONE	1400 U				20 U	1000 U		
BENZENE	350 U				5.1 U	260 U		
BROMODICHLOROMETHANE	350 U				5.1 U	260 U		
BROMOFORM	350 U				5.1 U	260 U		
BROMOMETHANE	700 UR				10 UR	520 U		
CARBON DISULFIDE	350 U				5.1 U	260 U		
CARBON TETRACHLORIDE	350 U				5.1 U	260 U		
CHLOROBENZENE	350 U				5.1 U	260 U		
CHLOROETHANE	700 UR				10 U	520 U		
CHLOROFORM	350 U				5.1 U	260 U		
CHLOROMETHANE	700 U				10 U	520 U		
CIS-1,2-DICHLOROETHENE	170 U				5.1 U	260 U		
CIS-1,3-DICHLOROPROPENE	350 U				5.1 U	260 U		
DIBROMOCHLOROMETHANE	350 U				5.1 U	260 U		
ETHYLBENZENE	350 U				5.1 U	260 U		
METHYLENE CHLORIDE	350 U				5.1 U	260 U		
STYRENE	350 U				5.1 U	260 U		
TETRACHLOROETHENE	350 U				5.1 U	260 U		
TOLUENE	350 U				5.1 U	260 U		
TRANS-1,2-DICHLOROETHENE	170 U				5.1 U	260 U		
TRANS-1,3-DICHLOROPROPENE	350 U				5.1 U	260 U		
TRICHLOROETHENE	350 U				5.1 U	260 U		
TRICHLOROTRIFLUOROETHANE	350 U				5.1 U	260 U		
VINYL CHLORIDE	700 U				10 U	520 U		
XYLENES, TOTAL	350 U				5.1 U	260 U		
Semivolatile Organics (ug/kg)								
1,2,4-TRICHLOROBENZENE	7000 U				1800 U	1800 U		
1,2-DICHLOROBENZENE	7000 U				1800 U	1800 U		
1,3-DICHLOROBENZENE	7000 U				1800 U	1800 U		
1,4-DICHLOROBENZENE	7000 U				1800 U	1800 U		
2,2'-OXYBIS(1-CHLOROPROPANE)	7000 U				1800 U	1800 U		
2,4,5-TRICHLOROPHENOL	7000 U				1800 U	1800 U		
2,4,6-TRICHLOROPHENOL	7000 U				1800 U	1800 U		

D-3

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Beth Page
AOC 22
Summary of Analytic Results
Subsurface Soils

nsample	TTNUS-22-SB-01-5456	TTNUS-22-SB-02-5759	TTNUS-22-SB-03-5557	TTNUS-22-SB-04-5759	TTNUS-22-SB-05-5559	TTNUS-22-SB-05-9599	TTNUS-22-SB-06-5557	TTNUS-22-SB-07-5557
sample	TTNUS-22-SB-01-5456	TTNUS-22-SB-02-5759	TTNUS-22-SB-03-5557	TTNUS-22-SB-04-5759	TTNUS-22-SB-05-5559	TTNUS-22-SB-05-9599	TTNUS-22-SB-06-5557	TTNUS-22-SB-07-5557
sample_dat	03-Jun-99	07-Jun-99	08-Jun-99	09-Jun-99	22-Jun-99	22-Jun-99	23-Jun-99	24-Jun-99
coll_metho	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
cto_proj	283	283	283	283	283	283	283	283
proj_manag	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.
2,4-DICHLOROPHENOL	7000 U				1800 U	1800 U		
2,4-DIMETHYLPHENOL	7000 U				1800 U	1800 U		
2,4-DINITROPHENOL	34000 U				8500 U	8500 U		
2,4-DINITROTOLUENE	7000 U				1800 U	1800 U		
2,6-DINITROTOLUENE	7000 U				1800 U	1800 U		
2-CHLORONAPHTHALENE	7000 U				1800 U	1800 U		
2-CHLOROPHENOL	7000 U				1800 U	1800 U		
2-METHYLNAPHTHALENE	7000 U				**3200**	**1700 J**		
2-METHYLPHENOL	7000 U				1800 U	1800 U		
2-NITROANILINE	34000 U				8500 U	8500 U		
2-NITROPHENOL	7000 U				1800 U	1800 U		
3&4-METHYLPHENOL	7000 U				1800 U	1800 U		
3,3'-DICHLOROBENZIDINE	34000 U				8500 U	8500 U		
3-NITROANILINE	34000 U				8500 U	8500 U		
4,6-DINITRO-2-METHYLPHENOL	34000 U				8500 U	8500 U		
4-BROMOPHENYL PHENYL ETHER	7000 U				1800 U	1800 U		
4-CHLORO-3-METHYLPHENOL	7000 U				1800 U	1800 U		
4-CHLOROANILINE	7000 U				1800 U	1800 U		
4-CHLOROPHENYL PHENYL ETHER	7000 U				1800 U	1800 U		
4-NITROANILINE	34000 U				8500 U	8500 U		
4-NITROPHENOL	34000 U				8500 U	8500 U		
ACENAPHTHENE	7000 U				1800 U	1800 U		
ACENAPHTHYLENE	7000 U				1800 U	1800 U		
ANILINE	7000 U				1800 U	1800 U		
ANTHRACENE	7000 U				1800 U	1800 U		
BENZO(A)ANTHRACENE	7000 U				1800 U	1800 U		
BENZO(A)PYRENE	7000 U				1800 U	1800 U		
BENZO(B)FLUORANTHENE	7000 U				1800 U	1800 U		
BENZO(G,H,I)PERYLENE	7000 U				1800 U	1800 U		
BENZO(K)FLUORANTHENE	7000 U				1800 U	1800 U		
BENZOIC ACID	34000 U				8500 U	8500 U		
BIS(2-CHLOROETHOXY)METHANE	7000 U				1800 U	1800 U		
BIS(2-CHLOROETHYL)ETHER	7000 U				1800 U	1800 U		
BIS(2-ETHYLHEXYL)PHTHALATE	7000 U				1800 U	1800 U		
BUTYLBENZYL PHTHALATE	7000 U				1800 U	1800 U		
CARBAZOLE	7000 U				1800 U	1800 U		
CHRYSENE	7000 U				1800 U	**980 J**		
DI-N-BUTYL PHTHALATE	7000 U				1800 U	1800 U		
DI-N-OCTYL PHTHALATE	7000 U				1800 U	1800 U		
DIBENZO(A,H)ANTHRACENE	7000 U				1800 U	1800 U		
DIBENZOFURAN	7000 U				1800 U	1800 U		
DIETHYL PHTHALATE	7000 U				1800 U	1800 U		
DIMETHYL PHTHALATE	7000 U				1800 U	1800 U		
FLUORANTHENE	7000 U				1800 U	1800 U		
FLUORENE	7000 U				**670 J**	1800 U		
HEXACHLOROBENZENE	7000 U				1800 U	1800 U		

D-4

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Beth Page
AOC 22
Summary of Analytic Results
Subsurface Soils

nsample	TTNUS-22-SB-01-5456	TTNUS-22-SB-02-5759	TTNUS-22-SB-03-5557	TTNUS-22-SB-04-5759	TTNUS-22-SB-05-5559	TTNUS-22-SB-05-9599	TTNUS-22-SB-06-5557	TTNUS-22-SB-07-5557
sample	TTNUS-22-SB-01-5456	TTNUS-22-SB-02-5759	TTNUS-22-SB-03-5557	TTNUS-22-SB-04-5759	TTNUS-22-SB-05-5559	TTNUS-22-SB-05-9599	TTNUS-22-SB-06-5557	TTNUS-22-SB-07-5557
sample_dat	03-Jun-99	07-Jun-99	08-Jun-99	09-Jun-99	22-Jun-99	22-Jun-99	23-Jun-99	24-Jun-99
coll_metho	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
cto_proj	283	283	283	283	283	283	283	283
proj_manag	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.
HEXACHLOROBUTADIENE	7000 U				1800 U	1800 U		
HEXACHLOROCYCLOPENTADIENE	34000 U				8500 U	8500 U		
HEXACHLOROETHANE	7000 U				1800 U	1800 U		
INDENO(1,2,3-CD)PYRENE	7000 U				1800 U	1800 U		
ISOPHORONE	7000 U				1800 U	1800 U		
N-NITROSO-DI-N-PROPYLAMINE	7000 U				1800 U	1800 U		
N-NITROSODIPHENYLAMINE	7000 U				1800 U	1800 U		
NAPHTHALENE	7000 U				1800 U	1800 U		
NITROBENZENE	7000 U				1800 U	1800 U		
PENTACHLOROPHENOL	34000 U				8500 U	8500 U		
PHENANTHRENE	**3000 J**				**2800**	**2500**		
PHENOL	7000 U				1800 U	1800 U		
PYRENE	7000 U				1800 U	**2300**		
Petroleum Hydrocarbons (mg/kg)								
DIESEL RANGE ORGANICS	**1900**	**21000**	**13000**	**12000**	**5400**		3.3 U	**1300 J**
GASOLINE RANGE ORGANICS	**78**	**300**	**140**	**250**	**44**		0.11 U	**23**

S-01

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AOC 22
Summary of Analytic Results
Subsurface Soils

nsample	TTNUS-22-SB-08-5557	TTNUS-22-SB-09-5557	TTNUS-22-SB-10-5557	TTNUS-22-SB-11-5355	TTNUS-22-SB-12-5860	TTNUS-22-SB-13-5759	TTNUS-22-SB-14-5759
sample	TTNUS-22-SB-08-5557	TTNUS-22-SB-09-5557	TTNUS-22-SB-10-5557	TTNUS-22-SB-11-5355	TTNUS-22-SB-12-5860	TTNUS-22-SB-13-5759	TTNUS-22-SB-14-5759
sample_dat	28-Jun-99	29-Jun-99	19-Jul-99	20-Jul-99	22-Jul-99	21-Jul-99	22-Jul-99
coll_metho	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
cto_proj	283	283	283	283	283	283	283
proj_manag	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.
Volatile Organics (ug/kg)							
1,1,1-TRICHLOROETHANE	5.6 U						
1,1,2,2-TETRACHLOROETHANE	5.6 U						
1,1,2-TRICHLOROETHANE	5.6 U						
1,1-DICHLOROETHANE	5.6 U						
1,1-DICHLOROETHENE	5.6 U						
1,2,3-TRICHLOROPROPANE	5.6 U						
1,2-DICHLOROETHANE	5.6 U						
1,2-DICHLOROETHENE (TOTAL)	5.6 U						
1,2-DICHLOROPROPANE	5.6 U						
2-BUTANONE	22 U						
2-HEXANONE	22 U						
4-METHYL-2-PENTANONE	22 U						
ACETONE	5.1 J						
BENZENE	5.6 U						
BROMODICHLOROMETHANE	5.6 U						
BROMOFORM	5.6 U						
BROMOMETHANE	11 U						
CARBON DISULFIDE	5.6 U						
CARBON TETRACHLORIDE	5.6 U						
CHLOROBENZENE	5.6 U						
CHLOROETHANE	11 U						
CHLOROFORM	5.6 U						
CHLOROMETHANE	11 U						
CIS-1,2-DICHLOROETHENE	2.8 U						
CIS-1,3-DICHLOROPROPENE	5.6 U						
DIBROMOCHLOROMETHANE	5.6 U						
ETHYLBENZENE	5.6 U						
METHYLENE CHLORIDE	2.8 J						
STYRENE	5.6 U						
TETRACHLOROETHENE	5.6 U						
TOLUENE	5.6 U						
TRANS-1,2-DICHLOROETHENE	2.8 U						
TRANS-1,3-DICHLOROPROPENE	5.6 U						
TRICHLOROETHENE	5.6 U						
TRICHLOROTRIFLUOROETHANE	5.6 U						
VINYL CHLORIDE	11 U						
XYLENES, TOTAL	5.6 U						
Semivolatile Organics (ug/kg)							
1,2,4-TRICHLOROBENZENE	370 U						
1,2-DICHLOROBENZENE	370 U						
1,3-DICHLOROBENZENE	370 U						
1,4-DICHLOROBENZENE	370 U						
2,2'-OXYBIS(1-CHLOROPROPANE)	370 U						
2,4,5-TRICHLOROPHENOL	370 U						
2,4,6-TRICHLOROPHENOL	370 U						

D-6

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Beth Page
AOC 22
Summary of Analytic Results
Subsurface Soils

nsample	TTNUS-22-SB-08-5557	TTNUS-22-SB-09-5557	TTNUS-22-SB-10-5557	TTNUS-22-SB-11-5355	TTNUS-22-SB-12-5860	TTNUS-22-SB-13-5759	TTNUS-22-SB-14-5759
sample	TTNUS-22-SB-08-5557	TTNUS-22-SB-09-5557	TTNUS-22-SB-10-5557	TTNUS-22-SB-11-5355	TTNUS-22-SB-12-5860	TTNUS-22-SB-13-5759	TTNUS-22-SB-14-5759
sample_dat	28-Jun-99	29-Jun-99	19-Jul-99	20-Jul-99	22-Jul-99	21-Jul-99	22-Jul-99
coll_metho	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
cto_proj	283	283	283	283	283	283	283
proj_manag	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.
2,4-DICHLOROPHENOL	370 U						
2,4-DIMETHYLPHENOL	370 U						
2,4-DINITROPHENOL	1800 U						
2,4-DINITROTOLUENE	370 U						
2,6-DINITROTOLUENE	370 U						
2-CHLORONAPHTHALENE	370 U						
2-CHLOROPHENOL	370 U						
2-METHYLNAPHTHALENE	370 U						
2-METHYLPHENOL	370 U						
2-NITROANILINE	1800 U						
2-NITROPHENOL	370 U						
3&4-METHYLPHENOL	370 U						
3,3'-DICHLOROBENZIDINE	1800 U						
3-NITROANILINE	1800 U						
4,6-DINITRO-2-METHYLPHENOL	1800 U						
4-BROMOPHENYL PHENYL ETHER	370 U						
4-CHLORO-3-METHYLPHENOL	370 U						
4-CHLOROANILINE	370 U						
4-CHLOROPHENYL PHENYL ETHER	370 U						
4-NITROANILINE	1800 U						
4-NITROPHENOL	1800 U						
ACENAPHTHENE	370 U						
ACENAPHTHYLENE	370 U						
ANILINE	370 U						
ANTHRACENE	370 U						
BENZO(A)ANTHRACENE	370 U						
BENZO(A)PYRENE	370 U						
BENZO(B)FLUORANTHENE	370 U						
BENZO(G,H,I)PERYLENE	370 U						
BENZO(K)FLUORANTHENE	370 U						
BENZOIC ACID	1800 U						
BIS(2-CHLOROETHOXY)METHANE	370 U						
BIS(2-CHLOROETHYL)ETHER	370 U						
BIS(2-ETHYLHEXYL)PHTHALATE	370 U						
BUTYLBENZYL PHTHALATE	370 U						
CARBAZOLE	370 U						
CHRYSENE	370 U						
DI-N-BUTYL PHTHALATE	370 U						
DI-N-OCTYL PHTHALATE	370 U						
DIBENZO(A,H)ANTHRACENE	370 U						
DIBENZOFURAN	370 U						
DIETHYL PHTHALATE	370 U						
DIMETHYL PHTHALATE	370 U						
FLUORANTHENE	370 U						
FLUORENE	370 U						
HEXACHLOROBENZENE	370 U						

B-7

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Beth Page
AOC 22
Summary of Analytic Results
Subsurface Soils

nsample	TTNUS-22-SB-08-5557	TTNUS-22-SB-09-5557	TTNUS-22-SB-10-5557	TTNUS-22-SB-11-5355	TTNUS-22-SB-12-5860	TTNUS-22-SB-13-5759	TTNUS-22-SB-14-5759
sample	TTNUS-22-SB-08-5557	TTNUS-22-SB-09-5557	TTNUS-22-SB-10-5557	TTNUS-22-SB-11-5355	TTNUS-22-SB-12-5860	TTNUS-22-SB-13-5759	TTNUS-22-SB-14-5759
sample_dat	28-Jun-99	29-Jun-99	19-Jul-99	20-Jul-99	22-Jul-99	21-Jul-99	22-Jul-99
coll_metho	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
cto_proj	283	283	283	283	283	283	283
proj_manag	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.	Brayack, D.
HEXACHLOROBUTADIENE	370 U						
HEXACHLOROCYCLOPENTADIENE	1800 U						
HEXACHLOROETHANE	370 U						
INDENO(1,2,3-CD)PYRENE	370 U						
ISOPHORONE	370 U						
N-NITROSO-DI-N-PROPYLAMINE	370 U						
N-NITROSODIPHENYLAMINE	370 U						
NAPHTHALENE	370 U						
NITROBENZENE	370 U						
PENTACHLOROPHENOL	1800 U						
PHENANTHRENE	370 U						
PHENOL	370 U						
PYRENE	370 U						
Petroleum Hydrocarbons (mg/kg)							
DIESEL RANGE ORGANICS	3.3 U	3.3 U	12	17 U	99	3.4 U	2.8 J
GASOLINE RANGE ORGANICS	0.11 U	0.11 U	0.12 U	0.096 U	0.13 U	0.100 U	0.110 U

D-9

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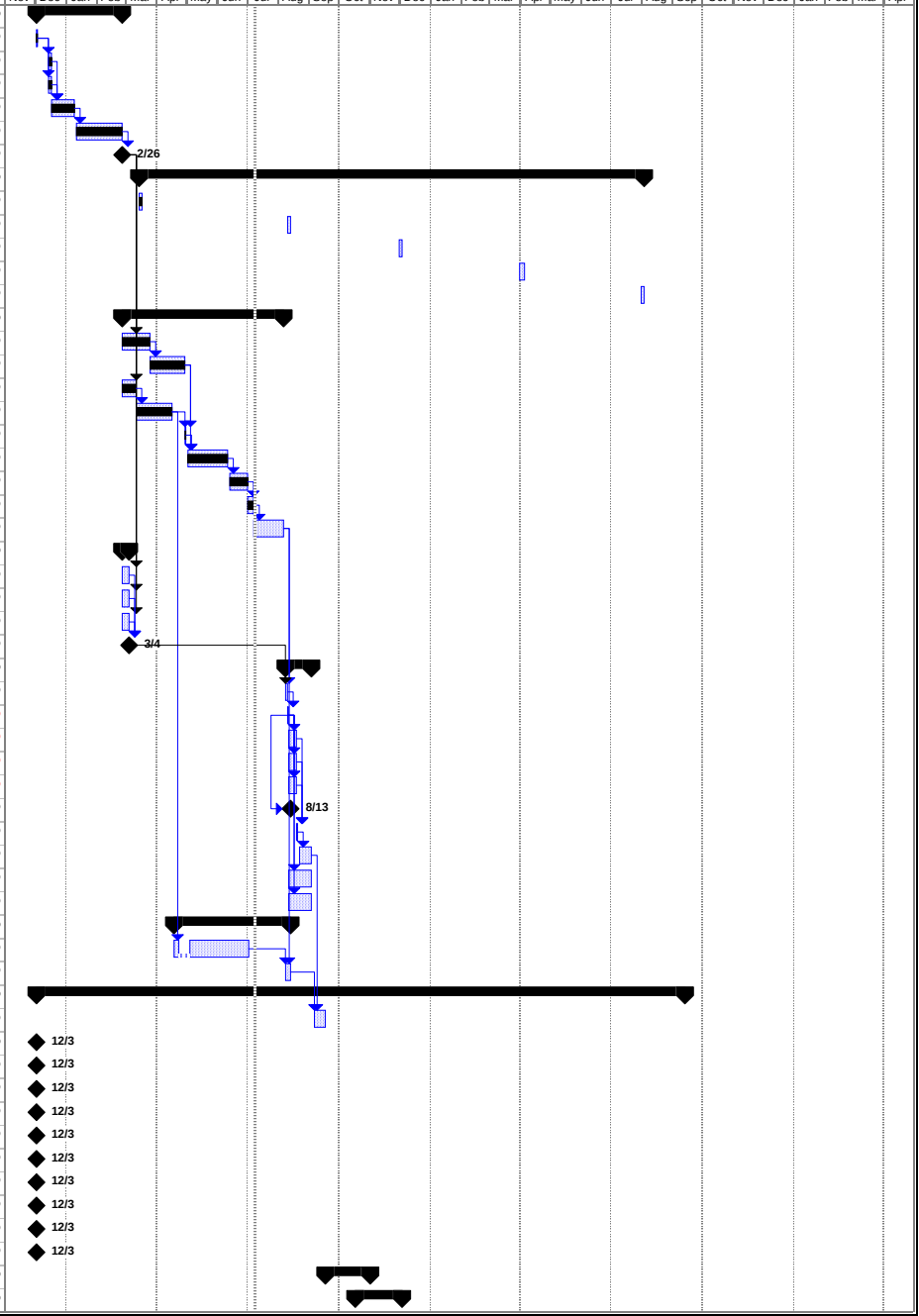
APPENDIX B

PROJECT SCHEDULE

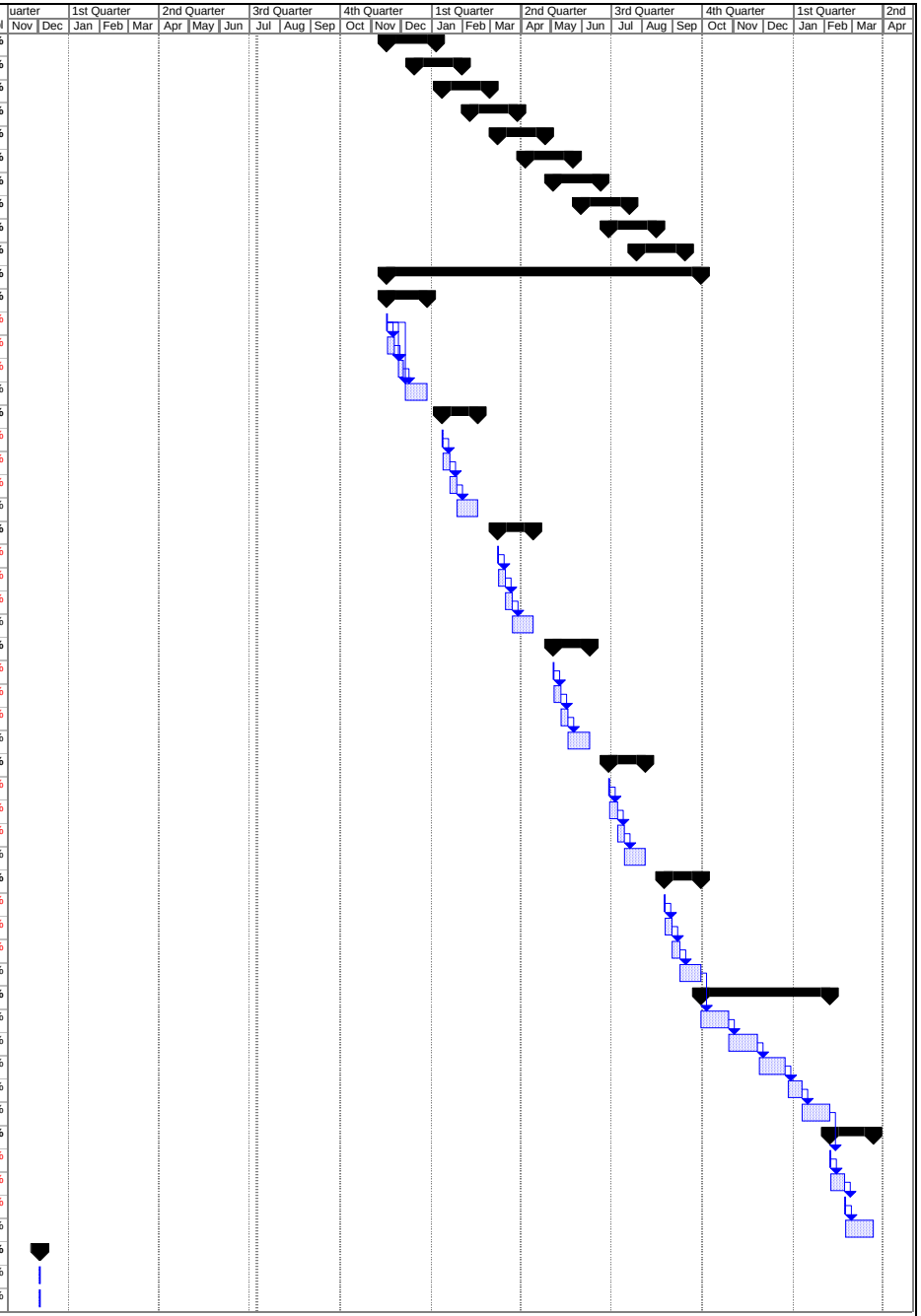
ID	Phase	ID	Task Name	Duration	Start	Finish	% Compl
1	**1000**	**1**	**Task 1 - Pre Design Meeting / Site Walk**	**56 days**	**Wed 12/3/03**	**Thu 2/26/04**	**100%**
2	1010	2	Fact Finding Conference Call	1 day	Wed 12/3/03	Wed 12/3/03	100%
3	1020	3	Pre Design Meeting	3 days	Mon 12/15/03	Wed 12/17/03	100%
4	1030	4	Site Walk	3 days	Mon 12/15/03	Wed 12/17/03	100%
5	1040	5	Project Proposal	11 days	Thu 12/18/03	Fri 1/9/04	100%
6	1050	6	Customer Review and Negotiations	34 days	Mon 1/12/04	Thu 2/26/04	100%
7	1060	7	Project Award	0 days	Thu 2/26/04	Thu 2/26/04	100%
8	**1500**	**8**	**Task 1.5 CLB Technology Introductions and Presentation**	**354 days**	**Mon 3/15/04**	**Wed 8/3/05**	**20%**
9	1510	9	Technology Introduction to NYSDEC	3 days	Mon 3/15/04	Wed 3/17/04	100%
10	1520	10	RAB Meeting 1 (August 2004)	3 days	Wed 8/11/04	Fri 8/13/04	0%
11	1530	11	RAB Meeting 2 (December 2004)	3 days	Wed 12/1/04	Fri 12/3/04	0%
12	1540	12	RAB Meeting 3 (April 2005)	3 days	Fri 4/1/05	Tue 4/5/05	0%
13	1550	13	RAB Meeting 4 (August 2005)	3 days	Mon 8/1/05	Wed 8/3/05	0%
14	**2000**	**14**	**Task 2 - Develop RAP, HASP, System Design Drawings**	**114 days**	**Fri 2/27/04**	**Fri 8/6/04**	**85%**
15	2010	15	Develop Remedial Action Plan, Health & Safety Plan 50% Drafts	20 days	Fri 2/27/04	Thu 3/25/04	100%
16	2020	16	Complete Remedial Action Plan, Health & Safety Plan Draft	25 days	Fri 3/26/04	Thu 4/29/04	100%
17	2030	17	Develop System Design	10 days	Fri 2/27/04	Thu 3/11/04	100%
18	2040	18	Develop System Design & Drawings	26 days	Fri 3/12/04	Fri 4/16/04	100%
19	2050	19	RAP, HASP, Design Presentation	1 day	Fri 4/30/04	Fri 4/30/04	100%
20	2060	20	NAVFAC, NYSDEC Review of Drafts	29 days	Mon 5/3/04	Fri 6/11/04	100%
21	2070	21	Response to NAVFAC, NYSDEC	14 days	Mon 6/14/04	Thu 7/1/04	100%
22	2080	22	Final Draft Submission	3 days	Fri 7/2/04	Wed 7/7/04	75%
23	2090	23	Final Draft - Client Approval (not to exceed 45 days)	22 days	Thu 7/8/04	Fri 8/6/04	0%
24	**3000**	**24**	**Task 3 - Site Construction, Environmental, and Drilling Permits**	**5 days**	**Fri 2/27/04**	**Thu 3/4/04**	**0%**
25	3010	25	Site Construction Permits (if Necessary)	5 days	Fri 2/27/04	Thu 3/4/04	0%
26	3020	26	Environmental Permits (if Necessary)	5 days	Fri 2/27/04	Thu 3/4/04	0%
27	3030	27	Drilling Permits (if Necessary)	5 days	Fri 2/27/04	Thu 3/4/04	0%
28	3040	28	Site Cleared for Work	0 days	Thu 3/4/04	Thu 3/4/04	0%
29	**4000**	**29**	**Task 4 - CLB Well and Piping Infrastructure Installation**	**20 days**	**Mon 8/9/04**	**Fri 9/3/04**	**0%**
30	4010	30	Utility Location (Potholing)	2 days	Mon 8/9/04	Tue 8/10/04	0%
31	4020	31	Drilling Mobilization	1 day	Wed 8/11/04	Wed 8/11/04	0%
32	4030	32	Drilling and Installation of 28 Deep Treatment Wells	6 days	Thu 8/12/04	Thu 8/19/04	0%
33	4040	33	Drilling and Installation of 6 Shallow Treatment Wells	6 days	Thu 8/12/04	Thu 8/19/04	0%
34	4060	34	Decontamination, Collection and Disposal of IDW	6 days	Thu 8/12/04	Thu 8/19/04	0%
35	4070	35	Drilling and Installation, Decon, IDW 50% Complete Milestone	0 days	Fri 8/13/04	Fri 8/13/04	0%
36	4080	36	Demobilization	1 day	Fri 8/20/04	Fri 8/20/04	0%
37	4090	37	Trenching and Infrastructure Installation	10 days	Mon 8/23/04	Fri 9/3/04	0%
38	4100	38	Soil Analytical	17 days	Thu 8/12/04	Fri 9/3/04	0%
39	4110	39	Groundwater Analytical	17 days	Thu 8/12/04	Fri 9/3/04	0%
40	**4500**	**40**	**Task 4.5 - Overhead Power Distribution System**	**83 days**	**Mon 4/19/04**	**Fri 8/13/04**	**0%**
41	4510	41	Design Coordination and Approval	47 days	Mon 4/19/04	Fri 7/2/04	0%
42	4520	42	Installation	5 days	Mon 8/9/04	Fri 8/13/04	0%
43	**5000**	**43**	**Task 5 - Start Up and Operation of the CLB System**	**449 days**	**Wed 12/3/03**	**Tue 9/13/05**	**0%**
44	5005	44	Mobilization and System Start Up	9 days	Tue 9/7/04	Fri 9/17/04	0%
45	**5010**	**45**	**System Performance (Sliding Scale)**	**0 days**	**Wed 12/3/03**	**Wed 12/3/03**	**0%**
46	5015	46	First Milestone 10% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
47	5020	47	Second Milestone 20% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
48	5025	48	Third Milestone 30% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
49	5030	49	Fourth Milestone 40% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
50	5035	50	Fifth Milestone 50% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
51	5040	51	Sixth Milestone 60% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
52	5045	52	Seventh Milestone 70% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
53	5050	53	Eighth Milestone 80% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
54	5055	54	Ninth Milestone 90% Reduction	0 days	Wed 12/3/03	Wed 12/3/03	0%
55	**5060**	**55**	**1st Treatment Cycle**	**31 days**	**Fri 9/17/04**	**Mon 11/1/04**	**0%**
74	**5155**	**74**	**2nd Treatment Cycle**	**33 days**	**Sun 10/17/04**	**Fri 12/3/04**	**0%**



Project: Bethpage CLB Pilot Demo
Date: Thu 7/8/04

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

ID	Phase	ID	Task Name	Duration	Start	Finish	% Compl
93	**5250**	**93**	**3rd Treatment Cycle**	**32 days**	**Tue 11/16/04**	**Wed 1/5/05**	**0%**
106	**5315**	**106**	**4th Treatment Cycle**	**32 days**	**Tue 12/14/04**	**Mon 1/31/05**	**0%**
119	**5380**	**119**	**5th Treatment Cycle**	**34 days**	**Tue 1/11/05**	**Mon 2/28/05**	**0%**
132	**5445**	**132**	**6th Treatment Cycle**	**34 days**	**Tue 2/8/05**	**Mon 3/28/05**	**0%**
145	**5510**	**145**	**7th Treatment Cycle**	**34 days**	**Tue 3/8/05**	**Mon 4/25/05**	**0%**
158	**5575**	**158**	**8th Treatment Cycle**	**34 days**	**Tue 4/5/05**	**Mon 5/23/05**	**0%**
171	**5640**	**171**	**9th Treatment Cycle**	**33 days**	**Tue 5/3/05**	**Mon 6/20/05**	**0%**
184	**5705**	**184**	**10th Treatment Cycle**	**34 days**	**Tue 5/31/05**	**Tue 7/19/05**	**0%**
197	**5770**	**197**	**11th Treatment Cycle**	**33 days**	**Tue 6/28/05**	**Mon 8/15/05**	**0%**
210	**5835**	**210**	**12th Treatment Cycle**	**34 days**	**Tue 7/26/05**	**Tue 9/13/05**	**0%**
223	**6000**	**223**	**Task 6 - Confirmation Borings**	**220 days**	**Wed 11/17/04**	**Thu 9/29/05**	**0%**
224	**6010**	**224**	**Soil Confirmation Boring 1**	**26 days**	**Wed 11/17/04**	**Mon 12/27/04**	**0%**
225	6020	225	Drilling Mobilization	1 day	Wed 11/17/04	Wed 11/17/04	0%
226	6030	226	Drilling and Sample Collection	5 days	Thu 11/18/04	Wed 11/24/04	0%
227	6040	227	IDW Collection, Transportation, and Disposal	5 days	Mon 11/29/04	Fri 12/3/04	0%
228	6050	228	Soil Analytical	15 days	Mon 12/6/04	Mon 12/27/04	0%
229	**6060**	**229**	**Soil Confirmation Boring 2**	**26 days**	**Wed 1/12/05**	**Wed 2/16/05**	**0%**
230	6070	230	Drilling Mobilization	1 day	Wed 1/12/05	Wed 1/12/05	0%
231	6080	231	Drilling and Sample Collection	5 days	Thu 1/13/05	Wed 1/19/05	0%
232	6090	232	IDW Collection, Transportation, and Disposal	5 days	Thu 1/20/05	Wed 1/26/05	0%
233	6100	233	Soil Analytical	15 days	Thu 1/27/05	Wed 2/16/05	0%
234	**6110**	**234**	**Soil Confirmation Boring 3**	**26 days**	**Wed 3/9/05**	**Wed 4/13/05**	**0%**
235	6120	235	Drilling Mobilization	1 day	Wed 3/9/05	Wed 3/9/05	0%
236	6130	236	Drilling and Sample Collection	5 days	Thu 3/10/05	Wed 3/16/05	0%
237	6140	237	IDW Collection, Transportation, and Disposal	5 days	Thu 3/17/05	Wed 3/23/05	0%
238	6150	238	Soil Analytical	15 days	Thu 3/24/05	Wed 4/13/05	0%
239	**6160**	**239**	**Soil Confirmation Boring 4**	**26 days**	**Wed 5/4/05**	**Thu 6/9/05**	**0%**
240	6170	240	Drilling Mobilization	1 day	Wed 5/4/05	Wed 5/4/05	0%
241	6180	241	Drilling and Sample Collection	5 days	Thu 5/5/05	Wed 5/11/05	0%
242	6190	242	IDW Collection, Transportation, and Disposal	5 days	Thu 5/12/05	Wed 5/18/05	0%
243	6200	243	Soil Analytical	15 days	Thu 5/19/05	Thu 6/9/05	0%
244	**6210**	**244**	**Soil Confirmation Boring 5**	**26 days**	**Wed 6/29/05**	**Thu 8/4/05**	**0%**
245	6220	245	Drilling Mobilization	1 day	Wed 6/29/05	Wed 6/29/05	0%
246	6230	246	Drilling and Sample Collection	5 days	Thu 6/30/05	Thu 7/7/05	0%
247	6240	247	IDW Collection, Transportation, and Disposal	5 days	Fri 7/8/05	Thu 7/14/05	0%
248	6250	248	Soil Analytical	15 days	Fri 7/15/05	Thu 8/4/05	0%
249	**6260**	**249**	**Soil Confirmation Boring 6**	**26 days**	**Wed 8/24/05**	**Thu 9/29/05**	**0%**
250	6270	250	Drilling Mobilization	1 day	Wed 8/24/05	Wed 8/24/05	0%
251	6280	251	Drilling and Sample Collection	5 days	Thu 8/25/05	Wed 8/31/05	0%
252	6290	252	IDW Collection, Transportation, and Disposal	5 days	Thu 9/1/05	Thu 9/8/05	0%
253	6300	253	Soil Analytical	15 days	Fri 9/9/05	Thu 9/29/05	0%
254	**7000**	**254**	**Task 7 - Final Report and Petition for Site Closure**	**90 days**	**Fri 9/30/05**	**Mon 2/6/06**	**0%**
255	7010	255	Final Report - 50% Draft	20 days	Fri 9/30/05	Thu 10/27/05	0%
256	7020	256	Final Report - Draft	20 days	Fri 10/28/05	Fri 11/25/05	0%
257	7030	257	NAVFAC, NYSDEC Review of Drafts	20 days	Mon 11/28/05	Fri 12/23/05	0%
258	7040	258	Final Draft Submission	10 days	Tue 12/27/05	Mon 1/9/06	0%
259	7050	259	Final Draft - Client Approval (not to exceed 45 days)	20 days	Tue 1/10/06	Mon 2/6/06	0%
260	**8000**	**260**	**Task 8 - Site Restoration**	**32 days**	**Tue 2/7/06**	**Wed 3/22/06**	**0%**
261	8010	261	Drill Rig Mobilization	1 day	Tue 2/7/06	Tue 2/7/06	0%
262	8020	262	Well Abandonment	10 days	Wed 2/8/06	Tue 2/21/06	0%
263	8030	263	Drill Rig Demobilization	1 day	Wed 2/22/06	Wed 2/22/06	0%
264	8040	264	Site Restoration	20 days	Thu 2/23/06	Wed 3/22/06	0%
265	**8050**	**265**	**Optional**	**1 day?**	**Wed 12/3/03**	**Wed 12/3/03**	**0%**
266	4050	266	Two Shallow Treatment Well Installation	1 day?	Wed 12/3/03	Wed 12/3/03	0%
267	8060	267	Two Shallow Treatment Well Abandonment	1 day?	Wed 12/3/03	Wed 12/3/03	0%



Project: Bethpage CLB Pilot Demo
Date: Thu 7/8/04

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

APPENDIX C

SAMPLING ANALYSIS PLAN

TABLE OF CONTENTS

SAMPLING AND ANALYSIS PLAN

1. PURPOSE

The purpose of the sampling and analysis plan is to evaluate the effectiveness of the closed-loop bioreactor (CLB) pilot study in Area of Concern (AOC) 22. The data will be compared to remedial action goals presented in Table 1 and to historical target compound list (TCL), soil sampling results, presented in Table 2 and presented on Figure 1-4. Historical TCL VOC soil data is summarized in Table 2.

Soil samples will be collected and analyzed for TPH using United States Environmental Protection Agency (EPA) Method 8015, VOCs using EPA Method 8260B and SVOCs using EPA Method 8270C. Groundwater samples will be analyzed for TPH using EPA Method 8015, SVOCs using EPA Method 8270C, VOCs using EPA Method 8260B, Nitrates/nitrites using EPA Method 353.2, surfactants using EPA Method 425.1, heterotropic plate counts using SM 9215B or equivalent, and petroleum hydrocarbon degraders using SM 9215B Modified or equivalent. Laboratory analyses of the environmental samples will be conducted in accordance with NYSDEC Analytical Services Protocol-Contract Laboratory Program (ASP-CLP) or U.S. Environmental Protection Agency (EPA) SW-846 methodologies. *Table 3* summarizes the field sampling programs.

The newly collected data will then be compared to previous sampling results and PRGs, and will be used to perform the following:

- Monitor the effectiveness of the CLB process
- Make adjustments/modifications to the CLB process
- Compare concentrations in soil to PRGs

This sampling and analyses plan (SAP) presents the procedures to be followed during the soil and groundwater sampling activities. Specifically, the SAP addresses:

- Technical approach
- Sampling program
- Quality assurance/quality control (QA/QC)

2. TECHNICAL APPROACH

To monitor the progress of the remedial program, soil and groundwater samples will be periodically collected. Soil samples will be collected from new soil borings beginning approximately 60 days after starting the system. Groundwater samples will be collected monthly following system startup. Prior to soil and groundwater sample collection, the CLB equipment will be shut down for 48 hours prior to sample collection. This should be a sufficient amount of time for the subsurface environment to come to equilibrium. After sampling has been completed, the CLB system will be restarted.

2.1. Soil Sampling Program

The soil sampling program will consist of the initial soil sampling performed during the well installation and subsequent soil samples events collected from borings on a bi-monthly basis (i.e., during months 2, 4, 6, 8, 10, and 12). The initial soil sampling event will serve as baseline data for this remedial program. Boring locations and sampling depths will be determined based on analytical results from the well installation program. Four (4) soil borings will be drilled using a hollow-stem auger drill rig during each sampling event. Samples will be collected every 10 feet from 20 to 60 feet below ground surface (bgs).

The soil boring program is designed based on historical soil data as well as the data that will be collected during the well infrastructure installation, combined with data collected in the field during O&M, and real-time results that will be obtained during implementation of this program. Samples will be submitted to an analytical laboratory for analysis of TPH, VOCs, and SVOCs. Selected soil samples may also be analyzed for the listed biological parameters.

2.2. Groundwater Sampling Program

The purpose for the collection and analyses of groundwater samples from monitoring and remediation wells is to screen the groundwater for biological conditions and changes in contaminant concentrations, not for the collection of long term monitoring data. The results of groundwater sampling events will be compared to the previous sampling events and will be the basis for modifications to the CLB operation.

Prior to the startup of the CLB system, an initial round of groundwater samples will be collected from selected wells. The initial groundwater sampling event will serve as baseline data for this remedial program. The progress of remediation system will also be monitored through the monthly collection of depth to groundwater measurements and groundwater samples from existing monitoring wells and selected remediation wells. A total of eight (8) groundwater samples will be collected during each of the monthly sampling events. The groundwater samples will be submitted to an analytical laboratory for analysis of TPH, SVOCs, VOCs, Nitrates/nitrites, surfactants, heterotropic plate counts, and petroleum hydrocarbon degraders.

3. SAMPLE PROCEDURES AND EQUIPMENT

The following sections provide the sampling procedures and equipment required to conduct the necessary field activities:

- Mobilization and demobilization
- Subsurface soil sampling
- Groundwater sampling
- Waste characterization and soil sampling
- Decontamination water sampling
- QA/QC samples

3.1. Mobilization and Demobilization

This subtask consists of field personnel orientation, equipment mobilization, and the staking of sampling locations. Each field team member will attend an on-site orientation meeting to become familiar with the history of the site, health and safety requirements, and field investigation procedures.

3.2. Subsurface Soil Sampling

Drilling will be performed with a truck-mounted hollow-stem auger drill rig to perform standard split-spoon sampling. Soil samples will be collected from designated locations in AOC 22. Soil borings, soil sampling and well constructions will be performed using a drill rig in accordance with the standard operation procedures (SOPs) presented in Section 5.

3.3. Groundwater Sampling

Eight groundwater samples per sampling event will be collected using disposable bailers. Groundwater samples will be collected in accordance with the SOPs presented in Section 5.

3.4. Waste Characterization Soil Sampling

An adequate number of composite soil sample of drill cuttings will be collected and submitted for analysis. The sample will be analyzed for TCLP, PCBs, ignitability, corrosively, and reactivity in addition to the analyses listed in Table 3.

3.5. Decontamination Water Sampling

Decontamination water will be containerized in 55-gallon drums for on-site storage. One composite sample will be collected from the drums and analyzed for TCL VOCs, TCL SVOCs, and TCL Metals, in addition to the analyses listed in Table 3.

3.6. QA/QC Samples

In addition to the environmental samples collected, quality assurance/quality control (QA/QC) samples will also be collected during the operational sampling program. Duplicate samples will be collected to provide an evaluation of the laboratory's performance by comparing analytical results of two samples from the same location. QA/QC procedures will be in accordance with the existing Quality Assurance Plan, *Final Remedial Investigation Quality Assurance Plan*, dated August 1991. The procedures detailed in this document will be more than adequate to ensure proper QA/QC.

Field blanks will be collected to provide an evaluation of field decontamination procedures and laboratory supplied water. Trip blanks will be submitted to the laboratory for TCL VOC analysis during the groundwater sampling. Trip blanks are reagent water samples, generated at the laboratory, and used to determine volatile organic analytes. Trip blanks are carried to the sampling site, through sampling conditions, without being opened, and shipped to the laboratory with other samples. The trip blank results are used to identify VOC artifacts arising from bottle preparation and sample handling activities.

3.6.1. Sample Preservation and Analytical Methods

Representative sampling of environmental matrices for chemical analysis depends on proper collection, preservation, shipping, custody, and preparation techniques. Improper preservation and/or shipping may jeopardize sample integrity and reduce data quality. The following sections provide information on the types and sizes of the sample containers, the preservation requirements, and the analytical methods to be used in this investigation.

3.6.2. Sample Containers and Preservation Requirements

Pre-cleaned sample containers will be provided and certified clean by the laboratory performing the analyses. Trip blanks will be used to evaluate the cleanliness of sample containers and the potential for contamination during transport of the field samples. A summary of container sizes, preservation requirements, and holding times for the Operational sampling program is provided in Table 3.

3.6.3. Analytical Methods

All analyses will be performed using standard USEPA and NYSDEC approved methods. Any modification to the standard methods will be identified and documented and the reason for the modification will be explained. All analyses will meet the requirements of the specific analytical method, including percent recoveries and method detection limit. At a minimum, the laboratory will have to achieve the quantitation limits for organic compounds. The methods to be used to analyze the samples collected are presented in Table 3.

4. QUALITY ASSURANCE/QUALITY CONTROL

Representative samples of environmental matrices for chemical analyses depend on proper collection, preservation, shipping, custody, and preparation techniques. Soil sampling is described in the Sampling Program section of this document, including the rationale, sampling locations, sampling procedures, and equipment. QA/QC procedures will be in accordance with the existing Quality Assurance Plan, *Final Remedial Investigation Quality Assurance Plan* dated August 1991, Halliburton NUS Environmental Corporation. The procedures detailed in this document will be more than adequate to ensure proper QA/QC.

4.1. Field Documentation

Field activities, including all sample handling activities, will be documented in the field logbook and chain of custody forms. All pertinent field activities performed, or observations made, will be recorded in bound field logbooks with sequentially numbered pages using waterproof ink. The documentation in the field logbooks will be sufficient to reconstruct the field activity. Information recorded in the logbook will include all aspects of sample collection, field measurements taken, site personnel, health and safety documentation, and selected aspects of field management. In addition to to the field log book, weekly progress reports summarizing progress for the week will be prepared and sumitted to EFANE NAVFAC.

4.2. Sample Identification

Proper sample documentation is important. All samples will be identified with a sample label before leaving the site. The sample label will be a white label with black lettering and waterproof adhesive backing. A sample label will be attached to each sample container. The label will be completed in waterproof ink using a Sharpie pen or similar marking device. Each sample will be designated by an alpha-numeric code that will identify the site and contain a sequential sample number. The following information will be included on the sample labels:

- Site name

- Field identification or sample station number
- Date and time of collection
- Name/signature of sampler
- General type of analysis to be performed

4.3. Sample Designation

A sample numbering system will be used to identify each sample, provide a tracking procedure to allow retrieval of information about a particular sample, and assure that each sample is uniquely numbered. The sample identification will consist of four components as described below. Duplicate samples will be designated with the next consecutive sample number. Identification that this is a duplicate sample will be made in the field logbook:

- **Site Identification -** The first component consists of a two letter designation which identifies the site. For this remedial action, the designation "BP" will be used as the identification for Bethpage.
- **Sample Type -** The second, which identifies the sample type, will consist of a four-letter/digit code which identifies the sampling location as follows:
  - SB-01 - Subsurface Soil Sample
  - GW-01 - Groundwater Sample
  - CW-01– Waste Classification Sample
- **Sample Location -** The third component identifies the sample interval, or identifies if the sample is a trip blank or field blank. A four digit number will be used to identify each sampling location. TB will be used to identify a trip blank and FB will be used to identify a field blank. An example of sample designation is: BP-SB-10-20, which represents the subsurface soil

sample collected from 20 to 22 feet bgs from Soil Boring 10 at the Bethpage Site AOC 22 facility.

4.4. Quality Assurance Samples

Quality control procedures will be employed to ensure that sampling and transport activities do not bias sample chemical quality. Trip blanks, field blanks, and duplicate samples will provide a quantitative basis for evaluation and validation of the data reported. In addition, analytical laboratory standard operating procedures that include the laboratory quality control procedures are included in Appendix E.

4.5. Sample Custody

The objectives of sample custody, identification, and control are:

- All samples scheduled for collection are uniquely identified
- The correct samples are tested and are traceable to their records
- Important sample characteristics are preserved
- Samples are protected from loss or damage
- A record of sample integrity is established

Each sample collected and shipped to an analytical laboratory will be listed on a chain of custody record. The purpose of the chain of custody is to document possession of the samples from collection through analysis. The following information will be supplied to complete the chain of custody record:

- Project name
- Signature of sampler
- Sampling location, date and time of collection

- Signature of individual involved in sample transfer (i.e., relinquishing or accepting samples). Individual receiving samples will sign, date, and note the time that they receive the samples on the form

- Particular analyses requested for each sample

Chain of custody forms will become permanent records of all sampling, handling, and shipping. Following sample collection and documentation, all sample containers will be prepared for shipment to the laboratory.

5. STANDARD OPERATING PROCEDURES

5.1. Standard Operating Procedure No. 1

5.1.1. Mobilization and Demobilization

This remedial activity consists of field personnel orientation, equipment mobilization, infrastructure installation, system operation and maintenance, confirmation sampling, and demobilization. Each field team member will attend an on-site orientation meeting to become familiar with the logistics of the site, health and safety requirements, and remediation and related field procedures.

- Equipment mobilization will entail the ordering, purchase, and if necessary, fabrication of all sampling supplies and equipment needed for any and all field activities. An inventory of available supplies/equipment will be conducted prior to initiating field activities, and all additional equipment required will be secured.

- Infrastructure installation mobilization will consist of staking all well and piping locations, prior to initiation of the work. All onsite subsurface utilities will be located and drilling locations will be potholed. After a location has been cleared, infrastructure installation in that area may begin.

- Equipment and personnel will be demobilized at the completion of each phase of field activities as necessary. Demobilization will also consist of site-area clean-up, staging and inventory of investigation-derived wastes, and organization of investigation records.

5.2. Standard Operating Procedure No. 2

5.2.1. Deep Subsurface Soil Boring Sampling (Split-Spoon)

All borings will be drilled with a Central Mining Equipment Company Model 75 hollow-stem auger drilling rig or equivalent. The auger flights to be used on this rig are 5 feet long, 8.5 inches inside diameter (ID), and 13.25 inches outside diameter (OD). The borehole diameter was approximately 13.5 inches.

Soil samples will be collected using a split-spoon sampler consisting of an outer two-piece sample barrel lined with four 6-inch-long, or six 4-inch-long brass sleeves (1.95 inches OD and 1.9 inches ID), placed end-to-end. When the desired sampling depth is reached, the sampler is lowered through the casing and driven into the undisturbed soil 12 to 18 inches. The sampler is then retrieved and the rings removed.

Soil contained in the lower ring(s) is retained for laboratory analysis. The ends of the lower ring(s) are sealed with Teflon tape and covered with plastic end caps which are secured with duct tape. The ends will be secured immediately following sample retrieval to maintain sample integrity. Soil in the remaining rings will be used for physical examination and lithologic description.

Soil samples will be labeled with sample identification number, name of sampler, date and time of sampling, and analysis required. The samples will then be placed on ice in a cooler for preservation of sample integrity during transportation. Soil sample information will be recorded the field notebook. CHAIN OF CUSTODY documentation will be completed for transport of the samples to the laboratory. Soil sample collection and CHAIN OF CUSTODY documentation procedures followed protocol accepted by federal, state, and local regulatory agencies.

5.3. Standard Operating Procedure No. 3

5.3.1. Water Level Measurement

Depth-to-water level will be measured using an electric water level measuring device or interface probe. The measuring device will be equipped with lighted and audio indicators for detection of water and oil. The depth of the water/oil in the well is then measured by noting the point on the graduated probe cable that corresponds to the measuring point of the well casing at the top when the electronic circuit is first completed. The accuracy of the probe is considered to be $\pm$ 0.01 foot.

Water/oil level measurements shall be recorded on the well sampling log. Entries on the form shall include, but are not limited to, the date and time the water/oil level measurements are taken, the individuals accomplishing the task, the well identification number or designation, the elevation of the top of the casing, the serial number or other identification number of the water level measuring device being utilized, and the depth to water level, recorded as the depth from the measuring point at the top of the

casing to the water level surface. Entries shall be signed by the person conducting the water level measurements.

5.3.2. ***Field Procedures***

1. Check the meter by turning on the indicator signal switch. The buzzer should sound and, if present, the indicator light should illuminate. If the water level indicator signal(s) is not functioning properly, check the batteries and/or use a different meter.

2. Decontaminate the probe and graduated cable as directed in SOP 6. The cable should be decontaminated only if the bottom of the well will be sounded. The length of cable to be decontaminated is determined by the distance between the water level and the bottom of the casing. This distance can be estimated from the completion log.

3. Holding the device at the top of the casing, lower the cable gradually into the well or piezometer until the indicator contacts the water surface.

4. Note the point on the graduated cable that corresponds to the measuring point at the top of the casing when the electronic circuit is first completed.

5. Record the value on the cable as the depth to water surface (to the nearest 0.01-foot).

6. Draw the cable part of the way up the casing, then lower it again, repeating the third through fifth steps. If these readings differ by more than 0.02 feet, repeat until the measured readings stabilize.

7. Remove the cable from the well.

8. To locate the bottom of the well, lower the cable slowly from the center of the casing. When the probe is felt to hit the bottom, or the cable slacks noticeably, draw the cable up very slowly until it is taut again.

9. Note the cable reading at the measuring point. Record this value as the well depth to the nearest 0.01-foot.

10. Repeat the final three steps to ensure the accuracy of the reading.

*5.3.3. **Maintenance***

Carry spare batteries for the water level measuring device at all times. Check the operation in the field before use by dipping the probe into a beaker of clean water. If the indicator does not function properly when tested, the device shall either be repaired and retested before further use, or shall be returned to the manufacturer for repairs and another measuring device substituted.

Clean the cable between measurements, as appropriate, by rinsing with distilled water and wiping dry with paper towels. In addition, clean the cable any time solids adhere to it.

Measure the cable monthly to determine if use of the instrument has caused the cable to stretch and, thereby, induce errors in measurements. The graduated cable shall be compared against a steel tape and discrepancies, if any, noted in a logbook.

*5.3.4. **Calculations***

The absolute water table elevation is calculated by subtracting the measured depth-to-water from the surveyed measuring point.

5.4. Standard Operating Procedure No. 4

5.4.1. Groundwater Sampling (Field Parameter Measurement)

Where more than one monitoring/remediation well within a specific well field or site is to be sampled, the sampling sequence will begin with the well expected to have the lowest analyte concentration, based on previous analytical results. Successive samples will be obtained from wells of increasing analyte concentration.

If the relative degree of suspected concentrations at the wells to be sampled cannot be reasonably assumed, sampling will proceed from the perimeter of the site toward the center of the site.

Groundwater samples will be collected by sending a new, disposable bailer down the well and filling the bailer and collecting a "grab sample" (due to the dynamic nature of the CLB process, well purging is not necessary). This sampling procedure will be performed until an adequate volume of sample has been obtained to fill all of the required sample bottles and analyze the sample for field parameters.

Field parameters (temperature, pH, specific conductance, and/or dissolved oxygen) will be monitored during sampling of the monitoring wells. Measurements will be conducted in accordance with the manufacturer's instructions and the following procedure:

1. Calibrate the water quality meter as per manufacturer's instructions.

2. Collect a water sample from the well using a new disposable bailer and place sample in an appropriate container.

3. All water quality measurements will be recorded in the appropriate field logbook.

4. The water quality meters will be decontaminated between wells by rinsing with deionized water (see Decontamination – field instrumentation).

After the field parameters have been collected and recorded in the field book, groundwater samples will be collected in appropriate sample bottles. Sample bottle filling and preservation procedures will be:

- **VOCs -** Fill each container with sample to just overflowing so that no air bubbles are entrapped inside. If effervescence occurs, submit the sample without preservative and note on the chain of custody form.

- **Other Parameters -** Fill each container and preserve immediately as required. To test for pH, pour a minimal portion of sample onto broad range pH paper to verify that the appropriate pH level has been obtained.

5.5. Standard Operating Procedure No. 5

5.5.1. Decontamination (Drilling Equipment)

Prior to the beginning of the drilling program and after each well completion, the drill rigs, tools, and associated drilling and development equipment, will be steam-cleaned with tap water. Well construction materials will be decontaminated prior to installation. Steam cleaning will be conducted within the designated decontamination area. Any decontamination fluids that result from steam cleaning operations will be stored in appropriate Department of Transportation (DOT)-approved 55-gallon drum until disposal.

Drill rods, bits, collars, augers, pipe wrenches, any other tools, and well construction materials will be placed on clean metal sawhorses or other supports and steam-cleaned until all visible sign of grease, oil, mud, or other material is removed. All equipment will be placed on clean plastic sheeting following decontamination. Brushes will be used as necessary to assist in the removal of extraneous materials or soil. New down-hole equipment will be decontaminated before utilization on-site. Drillers will wear new, cotton work gloves while handling cleaned drill rig equipment. The Health and Safety Plan (HASP) will dictate any additional protective measures.

5.6. Standard Operating Procedure No. 6

5.6.1. Decontamination (Field Instrumentation - Probes, Water Quality Meters, etc.)

Field instrumentation (such as interface probes, water quality meters, etc.) will be decontaminated between sample locations by rinsing with deionized water. If visible contamination still exists on the equipment after the rinse, an Alconox detergent scrub will be added, and the probe thoroughly rinsed again. Decontamination of sampling equipment will be kept to a minimum in the field and wherever possible, dedicated disposable sampling equipment will be used. Any decontamination fluids generated will be stored in U.S. DOT-approved 55-gallon drums or in an on-site storage tank (liquids only) until disposal. Personnel directly involved in equipment decontamination will wear appropriate protective clothing, as stated in the SHSP.

Decontamination of non-disposable sampling equipment used to collect samples for chemical analyses (i.e., scoops, trowels, bowls, split-spoons, etc.) will be conducted as described below:

1. Alconox detergent and potable water scrub
2. Potable water rinse
3. Deionized water rinse
4. Air dry
5. Wrap or cover exposed ends of equipment with aluminum foil for transport and handling. Decontamination of sampling equipment will be kept to a minimum in the field and wherever possible, dedicated disposable sampling equipment will be used if applicable.

APPENDIX D

HEALTH AND SAFETY PLAN

APPENDIX E

LABORATORY ANALYTICAL STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE
DETERMINATION OF DIESEL RANGE ORGANICS BY 8015M GC/FID

Applicable Matrices: Water, Soil and Sediment
Standard Compound List and Reporting Limits: See Appendix A

APPROVAL SIGNATURES

Laboratory Director: Michael F. Wheeler, Ph.D. Date: 9/16/03

QA Manager: Kirstin L. McCracken Date: 9/16/03

Supervisor: Jennifer L. Clements Date: 09/16/03

Proprietary Information Statement:

1.0 SCOPE AND APPLICATION

1.1. This SOP describes the laboratory procedure used to determine the concentration of diesel range organics (DRO) in aqueous, soil, sediment, and waste. DROs (diesel and motor oil) correspond to the range of alkanes from C10 to C28.

1.2. The reporting limit for each target compound is provided in Table 1, Section 17.0.

2.0 SUMMARY OF METHOD

2.1. Samples are solvent extracted by Method 3550 (soils) or Method 3510 (aqueous) following approved laboratory standard operating procedures. Following solvent extraction, the extracts are introduced to the GC by auto sampler, and the detection of target analyte is achieved flame ionization detector (FID).

2.2. This procedure is based on Method 8015 Nonhalogenated Organics Using GC/FID as applicable to the analysis of petroleum hydrocarbons including diesel range organics (DRO), Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition September 1986.

3.0 DEFINITIONS

3.1. A list of terms and definitions is given in Appendix B.

4.0 INTERFERENCES

4.1. Method interference may be caused by contaminants in the extraction solvent. Solvents should be stored in an area away from organochlorine compounds to minimize contamination.

4.2. Matrix interferences may be caused by contaminants co-extracted from the sample. The extent of the interferences will vary considerably depending on the nature and diversity of the samples. Because the flame ionization detector is a non-selective detector, there is a potential for interference from many non-target compounds.

5.0 SAFETY

5.1. Employees must trained on and adhere to the policies and procedures for safety in the Corporate Safety Manual and this document.

5.1.1. Safety Concerns or Requirements

The gas chromatograph contains zones that have elevated temperatures. The analyst should be aware of the locations of those zones, and should cool them to room temperature prior to working on the instrument. The GC also has areas of high voltage. Depending on the type of work involved, the instrument should be turned off or disconnected from its source of power prior to extensive maintenance.

5.1.2. Primary Materials Used

Table 2, Section 17.0 lists those materials used in this procedure that have a serious or significant hazard rating along with the exposure limits and primary hazards associated with that material as identified in the MSDS. The table does not include all materials used in the procedure. A complete list of materials used can be found in section 7.0. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS. Any questions regarding the safe handling of these materials should be directed to the laboratory's Environmental Health and Safety Coordinator.

6.0 EQUIPMENT AND SUPPLIES

6.1. Autosampler vials

6.2. Class "A" volumetric syringes (Hamilton) ± 1% accuracy

6.3. Gas Chromatograph: An analytical system complete with a temperature programmable gas chromatograph equipped with a split/splitless or packed injection port, flame ionization detector, and an autosampler.

6.4. Recommended Column: A single silica capillary column system.

- RTX-5, (30m x 0.25 mmID x 0.25um)
- Equivalent columns may be used, provided the elution orders are documented and compound separations are maintained.

6.5. Detector: A Flame Ionization Detector (FID).

6.6. Autosampler: Capable of making 2uL injections.

6.7. Data system: Capable of handling a minimum of 200 chromatographic peaks per detector.

- Fisions Vax based Multichrom Version 2.0 or higher (used for acquisition).
- Target Version 3.5 or higher (used for processing data and report generation).

7.0 REAGENTS AND STANDARDS

7.1. Solvents: Acetone, Methlylene Chloride. Store away from other solvents.

7.2. Stock standard solutions are purchased pre-certified from commercial vendors. Working standard solutions are prepared in the laboratory by dissolving a volume of standard solution in solvent and diluting to a specified volume. The recommended "recipes" for the standards used in this procedure are provided in Appendix A.

8.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

8.1. Sample extracts must be stored at 4°C ± (2°C) until the time of analysis.

8.2. The analytical holding time is 40 days from the date of sample extraction.

8.3. Unless otherwise specified by a federal, state or client specific requirement, extracts are stored from the time of receipt until 30 days after delivery of the reconciled data package report and then disposed of in a manner that complies with all applicable regulations.

9.0 QUALITY CONTROL

9.1. Method Blank (MB)
A method blank is analyzed per preparation batch of 20 or fewer samples. The concentration of target analyte in the MB must be less than or equal to the reporting limit. If target analyte is found in the MB, the source of contamination is investigated and actions are taken to minimize or eliminate the problem. Samples processed with the contaminated method blank should be re-extracted and reanalyzed or data should be qualified if the concentration of target analyte in the blank is at or above the reporting limit and is greater than 1/10 the amount measured in any sample or if the blank contamination otherwise affected the sample results per the project data quality objectives. Unless otherwise noted in the sampling and analysis plan, for DOD work, the concentration of target analytes in the MB must be less than or equal to 1/2 RL except for common laboratory contaminants, which must be less than or equal to the RL.

9.2. Laboratory Control Sample (LCS)
A laboratory control sample is analyzed per preparation batch of 20 or fewer samples. The recovery of the LCS should be within the acceptance criteria given in Table 1, Section 17.0. If the LCS recovery is not within limits, the problem should be investigated and corrected. The LCS and all samples in the associated batch should be re-extracted and reanalyzed or the data should be reported with appropriate data qualifiers.

9.3. Matrix Spike/Matrix Spike Duplicate (MS/MSD)
Matrix spikes are used to assess the effect of the sample matrix on the precision and accuracy of method. The results of matrix spike are sample/matrix specific and are not used to determine validity of an entire analytical batch. The client should determine the frequency of the MS/MSD analysis on their project samples as part of their project data quality objectives. For DOD, the minimum frequency recommended for matrix spike analysis is one MS/MSD per 20 project samples per matrix.

The recovery of the MS/MSD should be within the advisory limits given in Table 1, Section 17.0 and the relative percent difference between the MS and the MSD should be less than or equal to 30%. If criteria are not met, the data should be reported with appropriate data qualifiers or project specific data quality objectives should be used to determine appropriate corrective action.

9.4. Surrogates

All field and QC samples are fortified with surrogate spike prior to extraction. The surrogate recovery should be within the acceptance criteria given in Table 1, Section 17.0. If surrogate recovery is not within criteria, the effect on individual sample results should be evaluated. QC and field samples should be re-extracted and reanalyzed for the failed surrogates if sufficient sample is available. If obvious chromatographic interference with the surrogate is present, reanalysis may not be necessary. Consult project specific data quality objectives to determine appropriate corrective action. Any results reported from analyses with surrogate recoveries outside acceptance criteria should be reported with appropriate data qualifiers.

10.0 CALIBRATION AND STANDARDIZATION

10.1. Chromatographic Conditions & Pre-Calibration Routine

Carrier Gas:	Helium
Injector Temperature:	290°C
Detector Temperature:	320°C
Temperature Program:	
▪ Initial Temperature	50°C hold for 4 minutes
▪ Program	50°C to 300°C at 20°C/min
▪ Final Temperature	300°C to 320°C, at 5°C/min

Attach a five-meter guard column to the injection port and the analytical column then attach the analytical column to the FID. Set the initial temperature to 50° and hold for 4.0 minutes. Ramp 20°C per minute to 300°C, ramp 5°C per minute to 320°C and hold for 5.5 minutes. Set the detector temperature to 320° and the injection port temperature to 290°. Use helium as the carrier gas and optimize the flow rate by injecting an unretained substance onto the column at an isothermal oven state and adjusting the flow to obtain the recommended dead volume time. Set the autosampler injection volume to 2-3uL.

10.2. Initial Calibration, Instrument Performance & Analytical Sequence

The instrument is calibrated using external standard calibration procedure with a minimum of five different concentrations for each fuel type (diesel & motor oil). The response used for the calibration represents the entire area of the chromatogram within the retention time range for DROs. The retention time range is defined during initial calibration with the analysis of retention time standards (RT). The results of the RT standards are used to determine integration points for the hydrocarbon envelope.

Analyze a methlylene chloride blank to verify that the system is free of contaminants. If contamination is found, investigate the source and correct prior to analysis of the calibration and retention time standards.

Prepare the mixed calibration standards using the procedure described in Appendix A. Analyze each calibration and retention time standard and using one of the following options, determine if the calibration is acceptable. If criteria are not met, correct the

problem and repeat the initial calibration.

Option 1: Linear-Least Squares Regression

Calculate the correlation coefficient. If r is $\geq$ 0.995 or (r^2) is $\geq$ 0.990 for the curve is considered acceptable.

Option 2: Response Factor

Calculate %RSD of the instrument response against the concentration of the calibration standard for each target analyte. If the %RSD is $\leq$ 20 % for each analyte, the curve is considered acceptable.

10.2.1 Initial Calibration Verification (ICV)
Immediately following initial calibration, analyze the second source calibration verification standard (ICV) standard (500ppm). The recovery of the ICV should be within ±20% of its expected value. If it is not, the problem should be investigated and corrected prior to further analysis. Recommended corrective actions are provided in Table 3, Section 17.0.

10.3. Continuing Calibration Verification (CCV)
Analyze a CCV daily before sample analysis, after every 10 field samples and at the end of the analysis sequence. All analytes should be within ±15%D of the expected value with no percent drift/difference for any individual analyte >20%D. If the CCV is not within criteria, correct the problem and reanalyze. If repeat failure, correct the problem and verify performance with two consecutive CCVs that pass criteria or repeat the initial calibration. If a CCV exhibits a high response (> 15%D) and the analyte is not detected in the samples, then the verification standard has demonstrated that the analyte would have been detected if present and reanalysis of samples is not necessary.

11.0 PROCEDURE

11.1 GC Analysis

Samples are analyzed in an analytical sequence that begins with instrument calibration or a daily CCV followed by analysis of sample extracts. Samples are analyzed with the same instrument operating conditions that were used for initial calibration and must be bracketed by with acceptable CCV and retention time criteria. The sequence ends when the CCV results indicate the calibration relationship is no longer valid.

An example analysis sequence that includes initial calibration is given below:

Instrument Blank	
ICAL Level 1	Diesel (100ppm) / Motor Oil (250ppm)
ICAL Level 2	Diesel (200ppm) / Motor Oil (500ppm)
ICAL Level 3	Diesel (500ppm) / Motor Oil (1000ppm)
ICAL Level 4	Diesel (1000ppm) / Motor Oil (2000ppm)
ICAL Level 5	Diesel (2000ppm) / Motor Oil (3000ppm)

RT Standards
Instrument Blank
ICV
10 Field Samples
CCV
10 Field Samples
CCV

Transfer the aliquot of extract to an auto sampler vial and place the vials in the autosampler. Enter the sample ID's into the data acquisition program, start the analytical sequence and acquire the data.

11.2. Qualitative & Quantitative Analysis

Evaluate the resulting chromatograms and calculated sample concentrations. Evaluate the QC results against the performance standards given in Section 9.0 and perform corrective action as necessary. Dilute and reanalyze any samples whose concentration exceeds the range of the calibration. *Note: A summary of acceptance criteria for each QC item is provided in Table 2 Section 17.2 along with recommended corrective actions.*

Identify target analytes using the integration points for the hydrocarbon envelope that were established by the retention time standards analyzed during initial calibration. Report quantitative results in appropriate units and significant figures and correct the results for sample volume, dilution factor and percent solids.

Although diesel fuel contains a large number of compounds that produce resolved peaks in a GC/FID chromatogram, diesel fuel also contains many other components that are not chromatographically resolved. The unresolved complex mixture results in a "hump" in the chromatogram that is characteristic with the fuel type. If the sample chromatograms do not match the characteristic pattern for diesel fuel or motor oil, data should be reported with the following data qualifiers:

Y: A fuel mixture pattern is detected, but the fuel mixture does not fall 90 percent within the calibration standard range and exhibit a reasonable pattern match to any of the calibrated fuels.

Z: Unknown single peaks or chromatographic patterns are detected but do not resemble a typical fuel patterns

12.0 CALCULATIONS

12.1. Aqueous Sample Concentration

$$Concentration_{sample}\,(ug/L) = Amt_{extract}\,(ug/L) \times \frac{extract\,volume\,(L)}{sample\,volume\,(L)} \times df$$

Where:
df= dilution factor

12.2. Soil Sample Concentration

$$Concentration_{sample}\ (ug/Kg) = Amt_{extract}\ (ug/L) \times \frac{extract\ volume(L)}{sample\ volume(Kg)} \times \frac{100}{\%\ solid} \times df$$

Where:
df= dilution factor

12.3. Percent Recovery (%R) (LCS and CCV)

$$\%R = \frac{SR}{SA} * 100\%$$

Where:
SR= Sample Result
SA=Concentration of Spike Added

12.4. Percent Recovery (%R) (Matrix Spike)

$$MSRecovery(\%) = \frac{SSR - SR}{SA} * 100\%$$

Where:
SSR= Matrix Spike Result
SR= Sample Result
SA=Concentration of Spike Added

12.5. Precision (RPD)

$$\%RPD = \frac{|D_1 - D_2|}{\frac{D_1 + D_2}{2}} * 100$$

Where:
D1 = Sample result
D2 = Matrix duplicate result

13.0 DATA ASSESSMENT, CRITERIA & CORRECTIVE ACTION

13.1. Samples, standards and QC samples are reviewed against the performance criteria given in section 9.0 for Quality Control. If the results do not fall within the established limits or criteria, corrective action should be performed. If corrective action is not taken or unsuccessful, the situation should be documented and reported in the project narrative. Primary review of the data is performed by the analyst(s) that performed the procedure. Secondary review is performed by a senior analyst or a data review analyst. All data that does not meet established criteria must be flagged with the appropriate data qualifier and noted in the project narrative.

14.0 METHOD PERFORMANCE

14.1. An Initial Demonstration of Capability is required for each analyst before unsupervised performance of this method.

14.2. A Method Detection Limit (MDL) determination for each test method referenced in this SOP is performed following the procedure described in the reference method, 40CFR, Part 136, Appendix B and laboratory SOP LP-LB-009. The MDL is verified or repeated when a significant change to the method occurs. Significant changes include the use of alternate reagents or standard reference materials, new instrumentation or the use of alternate sample preparation procedures.

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1. Where reasonably feasible, technological changes have been implemented to minimize the production of hazardous waste and minimize potential source of pollution to the environment.

15.2. Hazardous waste generated by this procedure is accumulated in satellite containers located in the work area. The satellite containers are labeled "Hazardous Waste" along with the type of waste category generated. Authorized personnel routinely transfer the contents of the satellite containers to the hazardous waste storage room for future disposal in accordance with Federal, State and Local regulations. The procedures for waste management are further given in laboratory SOP LP-LB-001 *Hazardous Waste.*

16.0 REFERENCES

16.1. Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996.

17.0 TABLES, DIAGRAMS, FLOWCHARTS

17.1. Table 1: *Target Analyte List, Reporting Limits, Accuracy and Precision Limits*
17.2. Table 2*: Primary Materials Used*
17.3. Table 3: *QC Summary and Recommended Corrective Action*

Table 1: Compound List and Reporting Limits (DRO 8015M)

Compound	RL *(mg/L)*	RL *(mg/Kg)*	Accuracy Limits %R	Precision Limit %RPD
Diesel Fuel	0.100	6.67	60-140	NA
Motor Oil	0.250	16.67	60-140	NA
MS/MSD	NA	NA	50-150	$\leq$ 30%
o-Terphenyl (surrogate)	NA	NA	60-140	NA

(1)The accuracy limits for the MS/MSD are considered advisory.
(2)The RL is adjusted in the final data report to account for dilution factor, percent solids, and sample volume.

Table 2: Primary Materials Used

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
1 – Always add acid to water to prevent violent reactions.			
2 – Exposure limit refers to the OSHA regulatory exposure limit.			

Table 3: QC Summary and Recommended Corrective Action (SW-846 8015M)

QC Item	Frequency	Acceptance Criteria	Recommended Corrective Action
Instrument Blank	Each Analytical Sequence	Target < RL	System Check, Reanalyze
Initial Calibration	As Required	R ≤ 0.995 r^2 ≤ 0.990 %RSD ≤ 20 percent	System Check, Reanalyze
ICV	Following ICAL	%R ±20% of expected value	System Check, Reanalyze, Prepare new standard solutions, Recalibrate, Reanalyze
CCV	Every 10 samples End of Analytical Sequence	± 15% Drift for each target analyte See Section 9.6.	Re-analyze immediately to confirm. System Check, Recalibrate. Reanalyze any samples not bracketed by acceptable CCV.
Method Blank (MB)	With each preparation batch of 20 samples or less	Target < RL	Evaluate field samples, Reanalyze, Re-extract
LCS	With each preparation batch of 20 samples or less	%R 60-140	System Check, Reanalyze, Recalibrate, Re-extract
MS/MSD	With every 20 field samples or as needed	%R 50-150 %RPD ≤ 30	Report outages in project narrative.
Surrogates	Every sample and QC item	%R 60-140	System Check, Reanalyze, Re-extract

**The recommended corrective action may include some or all of the items listed in this column. The analyst must use professional judgment to investigate and correct problems before proceeding with analysis. Suspect data must be qualified and reported in the project narrative.*

Appendix A: Standard Preparation Tables

The standard preparation tables provided in this appendix are accurate only when the specified concentrations and volumes are used. Any time the concentration or volume of any of the components change, the analyst must adjust the "recipe" accordingly. See laboratory SOP LP-LB-002 *Standard Preparation* for further guidance.

All prepared standards must be labeled with the lot number, name of the standard, concentration, and the expiration date. The expiration date of TPH standards is 6 months from the date or preparation as long as this date is supported by the expiration date of the parent standard. Otherwise, the expiration date of the parent materials is used.

Table Legend:

Cstock = Concentration of Parent Standard(s)
Vstock = Volume of Parent Standard
Vspike = Volume of Prepared Standard
Cspike = Theoretical Concentration of Prepared Standard

Working Standard Solutions

Composite Standard Diesel Fuel #2, Restek Catalog #31258
Composite Standard Motor Oil, Restek Catalog # 31464
o-Terphenyl Standard, Restek Catalog #31066

Diesel (100ppm) / Motor Oil (250ppm)

Stock Standard (Restek)	*Cstock (mg/L)*	*Vstock (uL)*	*Vspike (mL)*	*C spike (mg/L)*
Diesel Fuel #2 Composite	50,000	8.0	4.0	100
Motor Oil Composite	50,000	20.0	4.0	250
o-Terphenyl	2000	10.0	4.0	5

Solvent: *Methylene Chloride*

Diesel (200ppm) / Motor Oil (500ppm)

Stock Standard (Restek)	*Cstock (mg/L)*	*Vstock (uL)*	*Vspike (mL)*	*C spike (mg/L)*
Diesel Fuel #2 Composite	50,000	16.0	4.0	200
Motor Oil Composite	50,000	40.0	4.0	500
o-Terphenyl	2000	20.0	4.0	10

Solvent: *Methylene Chloride*

Diesel (500ppm) / Motor Oil (1000ppm)

Stock Standard (Restek)	*Cstock (mg/L)*	*Vstock (uL)*	*Vspike (mL)*	*C spike (mg/L)*
Diesel Fuel #2 Composite	50,000	40.0	4.0	500
Motor Oil Composite	50,000	80.0	4.0	1000
o-Terphenyl	2000	40.0	4.0	20

Solvent: *Methylene Chloride*

Diesel (1000ppm) / Motor Oil (2000ppm)

Stock Standard (Restek)	*Cstock (mg/L)*	*Vstock (uL)*	*Vspike (mL)*	*C spike (mg/L)*
Diesel Fuel #2 Composite	50,000	80	4.0	1000
Motor Oil Composite	50,000	160	4.0	2000
o-Terphenyl	2000	80	4.0	40

Solvent: *Methylene Chloride*

Diesel (2000ppm) / Motor Oil (3000ppm)

Stock Standard (Restek)	*Cstock (mg/L)*	*Vstock (uL)*	*Vspike (mL)*	*C spike (mg/L)*
Diesel Fuel #2 Composite	50,000	160	4.0	2000
Motor Oil Composite	50,000	240	4.0	3000
o-Terphenyl	2000	100	4.0	50

Solvent: *Methylene Chloride*

Diesel ICV Standard (500ppm)

Stock Standard (Restek)	*Cstock (mg/L)*	*Vstock (uL)*	*Vspike (mL)*	*C spike (mg/L)*
Diesel Fuel #2 Composite*	50,000	40	4.0	500
o-Terphenyl	2000	40	4.0	20

Solvent: *Methylene Chloride*

* Ultra Scientific Catalog #RGO-616-1

Retention Time Standard

Stock Standard	*Cstock (mg/L)*	*Vstock (mL)*	*Vspike (mL)*	*C spike (mg/L)*
C10	5000	0.020	10	10
C23	5000	0.020	10	10
C28	5000	0.020	10	10

Solvent: *Methylene Chloride*

Appendix B: Terms & Definitions

Batch: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Continuing Calibration Verification (CCV): a single or multi-parameter calibration standard used to verify the stability of the method over time. Usually from the same source as the calibration curve.

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Initial Calibration Verification (ICV): solution prepared from a separate source from that which is used to prepare the calibration curve.

Intermediate Standard: a solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Duplicate (MD): duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Method Detection Limit (MDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs. Quantitative results are not produced in this range.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample. The RL must be minimally at or above the MDL.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

METHOD 8260B
STANDARD OPERATING PROCEDURE
THE DETERMINATION OF VOLATILE ORGANIC COMPOUNDS
BY GAS CHROMATOGRAPHY/MASS SPECTROSCOPY

Applicable Matrices: Ground and Surface Water,
Waste Solvents, Oily Wastes, Soils and Sediments
Standard Compound List and Reporting Limits: See Table 1

APPROVAL SIGNATURES

Laboratory Director: Michael F. Wheeler, Ph.D. Date: 12/18/03

QA Manager: Kirstin L. McCracken Date: 12-17-03

Organics Technical Director: Bryce E. Stearns Date: 12/18/03

Proprietary Information Statement:

1.0 SCOPE AND APPLICATION

1.1. This SOP is based on Method 8260B (USEPA Test Methods for Evaluating Solid Waste, Dec. 1996). Method 8260B describes the GC/MS procedure for the analysis of volatile organic compounds. The techniques by which compounds may be introduced into the GC/MS system are described in Method 5030 (purge-and-trap of aqueous samples) and Method 5035 (purge-and-trap of solid and waste oil samples). This method is applicable to nearly all types of samples regardless of water content, including ground and surface water, waste solvents, oily wastes, soils and sediments. The compounds amenable to this method are shown in Table 1. A chromatographic column utilizing a temperature program is used to separate the desorbed purgeables followed by mass spectral detection.

2.0 SUMMARY OF METHOD

2.1. Basic Principles - The analytes are introduced into the GC/MS by purge-and-trap techniques (Method 5030 or Method 5035). Upon desorption from the trap, the volatile compounds are introduced directly to a wide-bore capillary column. A temperature program is used to separate the purgeables. The eluted analytes pass through a jet separator and they are carried on the gas stream into the ion source of a mass spectrometer. The ionized molecules are focused and separated according to their mass/charge (m/z) ratio by the quadrupole analyzer. The signal is amplified by an electron multiplier and interpreted by the mass spectrometer data system to produce a total ion chromatogram and mass spectra for every data point on the chromatogram.

2.2. General Method - The mass spectrometer is calibrated to recognize m/z values in the range of 35-300 amu. Reference spectra and retention times for analytes are obtained by the measurement of calibration standards under the same conditions used for samples. Analytes are quantitated using procedural standard calibration. The concentration of each identified component is measured by relating the MS response of the quantitation ion produced by that compound to the MS response of the quantitation ion produced by a compound that is used as an internal standard. The performance of the mass spectrometer is verified by the injection of 4-Bromofluorobenzene (BFB). Next, the instrument must demonstrate acceptable chemical calibration and linearity by the analysis of five concentrations of a standard mix containing the analytes of interest, as well as the surrogates and internal standards. Before any samples are analyzed, a method blank must be analyzed to demonstrate that the instrument is free from contamination, and that surrogate recovery criteria are met. All analyses must occur within 12 hours of the injection of the passing BFB. Another analytical sequence may be started by the analysis of a passing BFB MS tune followed by a continuing calibration standard.

3.0 DEFINITIONS

3.1. Definitions are included in Appendix A.

4.0 INTERFERENCES

4.1. During analysis, major contaminant sources are volatile materials in the laboratory and impurities in the inert purging gas and in the sorbent trap. The use of Teflon tubing, Teflon thread sealants, or flow controllers with rubber components in the purging device should be avoided since such materials out-gas organic compounds which will be concentrated in the trap during the purge operation. Analyses of laboratory reagent blanks provide information about the presence of contaminants. Subtracting blank values from sample results is not permitted.

4.2. Interfering contamination may occur when a sample containing low concentrations of volatile organic compounds is analyzed immediately after a sample containing relatively high concentrations of volatile organic compounds. A preventive technique is between-sample rinsing of the purging apparatus and sample syringes with two to three portions of reagent water. After analysis of a sample containing high concentrations of volatile organic compounds, one or more laboratory reagent blanks should be analyzed to check for cross-contamination.

4.3. Special precautions must be taken to determine methylene chloride. The analytical and sample storage area should be isolated from all atmospheric sources of methylene chloride; otherwise, random background levels will result. Since methylene chloride will permeate Teflon tubing, all GC carrier gas lines and purge gas plumbing should be constructed of stainless steel or copper tubing. Laboratory worker's clothing should be cleaned frequently since clothing previously exposed to methylene chloride fumes during common extraction procedures can contribute to sample contamination. Extraction laboratory personnel should not enter the volatile analytical laboratory.

4.4. Traces of ketones, methylene chloride, and some other organic solvents can be present even in the highest purity methanol. This is another potential source of contamination, and should be assessed before standards are prepared in the methanol.

5.0 SAFETY

5.1. The toxicity or carcinogenicity of each reagent used in this method has not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable. Cautions are included for known extremely hazardous materials or procedures.

5.2. STL Burlington maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. Material Safety Data Sheets (MSDS) are made available to all personnel involved in the chemical analysis. STL Burlington also has a written environmental health and safety plan.

5.3. Please note chemicals that have the potential to be highly toxic or hazardous, the appropriate MSDS must be reviewed by the employee before handling the chemical. The following method analytes have been tentatively classified as known or suspected human or mammalian carcinogens: benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichlorethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, chloroform, 1,2-dibromoethane, tetrachloroethene, trichloroethene, and vinyl chloride. Pure standard materials and stock standard solutions of these compounds should be handled in a hood.

6.0 EQUIPMENT AND SUPPLIES

6.1. Containers

6.1.1. Sample Storage Containers: 40 mL screw cap vials equipped with a Teflon faced silicone septum, certified clean, known volume of 44 mL (see also Method 5035)

6.1.2. Standard Storage Containers: 1-5 mL Mininert vials with Teflon lined screw caps

6.2. Syringes

6.2.1. 250 µL - 10 mL gas tight hypodermic syringes with Luer-Lok tip

6.2.2. Micro syringe 10 - 100 µL

6.3. Instrumentation

6.3.1. VOA Autosampler: Tekmar ALS 2050, Tekmar AQUATEK 50, or equivalent

6.3.2. Varian Chromatography Systems Archon Purge-and-Trap

6.3.3. Purge & Trap: Tekmar LSC 2000; VOCARB 3000 trap or equivalent

6.3.4. Gas Chromatograph: Hewlett-Packard 5890 Series II

6.3.5. Mass Spectrometer: Hewlett-Packard 5971 MSD, Hewlett-Packard 5972 MSD

6.3.6. Primary Column: Fused silica capillary column, J&W DB624 75 m x 0.53 mm x 3.0 um or equivalent

6.4. Data System - Hewlett-Packard ChemStations software is used for data acquisition and ChemServer, Target 3.5 software is used for data processing

7.0 REAGENTS AND STANDARDS

7.1. Trap Packing Materials - VOCARB 3000 or equivalent traps may be used, following the manufacturer's instructions.

7.2. Reagents

7.2.1. Methanol - Purge and Trap Grade, demonstrated to be free of analytes.

7.2.2. Reagent water - Deionized water is filtered using a Milli Q plus ™ filtration system and then boiled for one hour. Finally, the water is purged with helium for a minimum of fifteen minutes. The water is stored in clean, narrow-mouth bottles with Teflon lined septa and screw caps.

7.2.3. Hydrochloric acid (1+1) - Measured volumes of conc. HCl are carefully added to an equal volume of reagent water.

7.2.4. Sodium Bisulfate ($NaHSO_4$) Solution - 20% wt/v. Preservative for soil samples (5035).

7.3. Stock Standard Solutions - These solutions are purchased as certified solutions or prepared from pure standard materials. Commercial standards arrive ampulized in concentrations ranging from 1-5 mg/mL.

7.4. Primary Dilution Standards - Stock standard solutions are used to prepare primary dilution standard solutions that contain all the analytes of interest in methanol. The primary dilution standards are prepared at concentrations that can be easily diluted to prepare aqueous calibration solutions that will bracket the working concentration range. The primary dilution standard is prepared at a concentration of 100 µg/mL (Low water analysis 25 µg/mL). Exceptions include the following: propionitrile at 400 µg/mL, tetrahydrofuran at 1000 µg/mL, 1,4-dioxane at 5000 µg/mL and isobutyl alcohol at 5000 µg/mL (Low water analysis exceptions: propionitrile at 100 µg/mL, acrolein and ketones at 125 µg/mL, tetrahydrofuran at 350 µg/mL, 1,4-dioxane and isobutyl alcohol at 1250 µg/mL). The primary dilution standard solutions are stored with minimal headspace and checked frequently for signs of deterioration or evaporation. Methanol solutions of gaseous standards are not stable for more than one week at <0°C.

7.5. Preparation of Calibration Standards - The five concentrations for the initial calibration are 5, 20, 50, 100, and 200 µg/L (propionitrile at 20, 80, 200, 400 and 800 µg/L, tetrahydrofuran at 50, 200, 500, 1000 and 2000 µg/L, 1,4-dioxane and isobutyl alcohol at 250, 1000, 2500, 5000 and 10000 µg/L). The calibration standards are prepared by adding 2.2 µL, 8.8µL, 22 µL, 44 µL, and 88 µL of the primary dilution standard to 44 mLs of reagent water. Internal standards are added by spiking 44 µL of the 50 µg/mL fortification solution. The primary dilution standard used to prepare the calibration standard contains the surrogate compounds at the same concentration as the analytes.

Soil calibrations are prepared at the same concentration levels as a water curve, 5, 10, 20, 50, 100, and 200 µg/L. Soil calibration standards are prepared by spiking the appropriate volume of the primary dilution standard and internal standard into a 5 mL gas tight syringe containing 5 mL of the sodium bisulfate solution. The standard is then injected into a standard 40 mL VOA vial containing a stir bar and sealed with the septum lined screw cap.

NOTE: Soil calibrations for Method 8260B_5035 need to be prepared in an aliquot of the sodium bisulfate solution, as does all blanks, ICVs, and LCSs.

For the low water analysis, the five concentrations for the initial calibration are 1, 5, 10, 25 and 50 µg/L (propionitrile at 4, 20, 40, 100 and 200 µg/L, acrolein and ketones at 5, 25, 50, 125 and 250 µg/L, tetrahydrofuran at 14, 70, 140, 350 and 700 µg/L, 1,4-dioxane and isobutyl alcohol at 50, 250, 500, 1250 and 2500 µg/L). The calibration standards are prepared by adding 1.8 µL, 8.8 µL, 17.6 µL, 44 µL, and 88 µL of the primary dilution standard to 44 mLs of reagent water. Internal standards are added by spiking 8.8 µL of

the 25µg/mL fortification solution. The primary dilution standard used to prepare the calibration standard contains the surrogate compounds at the same concentration as the analytes.

Additionally, for manual injections these standards may be prepared in a 5 mL gas tight syringe and spiked with the appropriate volumes to achieve the analyte concentrations specified above.

7.6. Preparation of Initial Calibration Verification (ICV) - Standards are obtained from a source external to the laboratory and independent from the source of the inital calibration standards. An ICV is prepared by spiking reagent water, in a 44 mL sample vial, with 44 µL of a fortification solution containing internal standards at a concentration of 50 µg/mL and 44 µL of a fortification solution containing surrogate compounds at a concentration of 50 µg/mL. The ICV is spiked by injecting 22 µL of the primary dilution standard at a concentration of 100µg/mL (propionitrile at 400 µg/mL, tetrahydrofuran at 1,000µg/mL, 1,4-dioxane and isobutyl alcohol at 5,000 µg/mL). All standards are spiked directly through the septum of the 44 mL vial.

For the low water analysis, the ICV is prepared by spiking reagent water, in a 44 mL sample vial, with 8.8 µL of a fortification solution containing internal standards at 25 µg/mL and 8.8 µL of the fortification solution containing surrogate standards at 25 µg/mL. The ICV is spiked by injecting 8.8 µL of the primary dilution standard at a concentration of 25 µg/mL (propionitrile at 100 µg/mL, acrolein and ketones at 125 µg/mL, tetrahydrofuran at 350 µg/mL, 1,4-dioxane and isobutyl alcohol at 1250 µg/mL). All standards are spiked directly through the septum of the 44 mL vial. Additionally, for manual injections these standards may be prepared in a 5 mL gas tight syringe and spiked with the appropriate volumes to achieve the analyte concentrations specified above.

7.7. Preparation of Continuing Calibration Verification (CCV) - Prepare this exactly like a calibration standard (Section 7.5). The compounds have a concentration of 50 µg/L (propionitrile at 200 µg/L, tetrahydrofuran at 500 µg/L, 1,4-dioxane and isobutyl alcohol at 2500 µg/L). For the low water analysis, the compounds have a concentration of 10 µg/L (propionitrile at 40 µg/L, acrolein and ketones at 50 µg/L, tetrahydrofuran at 140 µg/L, 1,4-dioxane and isobutyl alcohol at 500 µg/L). Additionally, for manual or soil injections these standards may be prepared in a 5 mL gas tight syringe and spiked with the appropriate volumes to achieve the analyte concentrations specified above and injected into the purge vessel (waters) or into a 40 mL vial containing a stir bar (soils).

7.8. Preparation of Laboratory Method Blank (VBLK) - A 44 mL sample vial is filled with reagent water (no air bubbles). Internal and surrogate standards are added separately by the injection of two 44 µL aliquots of the fortification solutions (containing internal standards and surrogate standards at 50 µg/mL) through the septum of the 44 mL sample vial. For the low water analysis, the internal and surrogate standards are added separately by the injection of two 8.8 µL aliquots of the fortification solutions (containing internal and surrogate standards at 25 µg/mL) through the septum of the 44 mL sample vial. For solid matrices, 5 grams of clean sand is added to a 44 mL sample vial. The

preservative technique utilized in the preparation of samples is performed on the method blank (addition of 5 mL of the sodium bisulfate solution). 5 mLs of reagent water containing 50 µg/L of internal and surrogate standards is spiked either manually or automatically through the septum of the vial. Additionally, for manual injections of the blanks may be prepared in a 5 mL gas tight syringe and spiked with the appropriate volumes to achieve the analyte concentrations specified above.

7.9. Preparation of Laboratory Control Sample (LCS) - A 44 mL sample vial is filled with reagent water (no air bubbles). Internal and surrogate standards are added separately by the injection of two 44 µL aliquots of the fortification solutions (containing internal standards and surrogate standards at 50 µg/mL) through the septum of the 44 mL sample vial. The LCS is spiked by injecting 22 µL of the primary dilution standard at 100 µg/mL (propionitrile at 400 µg/mL, tetrahydrofuran at 1000 µg/mL, 1,4-dioxane and isobutyl alcohol at 5000 µg/mL) through the septum of the 44 mL sample vial. For solid samples, 5 grams of clean sand is placed in a 44 mL sample vial. The LCS is prepared by initially spiking a 5 mL syringe with two 5 µL aliquots of both fortification standards at a concentration of 50 µg/mL. 2.5 µL of the primary dilution standard at a concentration of 100 µg/mL (propionitrile at 400 µg/mL, tetrahydrofuran at 1000 µg/mL, 1,4-dioxane and isobutyl alcohol at 5000 µg/mL) is spiked into the same syringe. The full 5 mLs of the syringe is then spiked onto the soil sample.

For the low water analysis, a 44 mL sample vial is filled with reagent water (no air bubbles). Internal and surrogate standards are added separately by the injection of two 8.8 µL aliquots of the fortification solutions (containing internal standards and surrogate standards at 25 µg/mL) through the septum of the 44 mL sample vial. The LCS is spiked by injecting 17.6 µL of the primary dilution standard at a concentration of 25 µg/mL (propionitrile at 100 µg/mL, acrolein and ketones at 125 µg/mL, tetrahydrofuran at 350 µg/mL, 1,4-dioxane and isobutyl alcohol at 1250 µg/mL) through the septum of the 44 mL sample vial.

Additionally, for manual injections the LCS may be prepared in a 5 mL gas tight syringe and spiked with the appropriate volumes to achieve the analyte concentrations specified above.

7.10. Preparation of Matrix Spike/Matrix Spike Duplicate (MS/MSD) - Matrix spikes and matrix spike duplicates are prepared and analyzed with each batch of 20 client specific samples of the same matrix. Internal and surrogate standards are added separately by the injection of two 44 µL aliquots of the fortification solutions (containing internal standards and surrogate standards at 50 µg/mL) through the septum of the 44 mL sample vial through the septum of the 44 mL sample vial. The MS/MSD is spiked by injecting 22 µL of the primary dilution standard at a concentration of 100 µg/mL (propionitrile at 400 µg/mL, tetrahydrofuran at 1000 µg/mL, 1,4-dioxane and isobutyl alcohol at 5,000 µg/mL) through the septum of the 44 mL sample vial. For solid samples, the MS/MSD is prepared by initially spiking a 5 mL syringe with two 5 µL aliquots of both fortification standards at a concentration of 50 µg/mL. 2.5 µL of the primary dilution standard at a concentration of 100 µg/mL (propionitrile at 400 µg/mL, tetrahydrofuran at 1000 µg/mL, 1,4-dioxane and isobutyl alcohol at 5,000 µg/mL) is spiked into the same

syringe. The full 5 mLs of the syringe is then spiked onto the soil sample contained in the sample vial.

For the low water analysis, internal and surrogate standards are added separately by the injection of two 8.8 µL aliquots of the fortification solutions (containing internal standards and surrogate standards at 25 µg/mL) through the septum of the 44 mL sample vial. The MS/MSD is spiked by injecting 17.6 µL of the primary dilution standard at a concentration of 25 µg/mL (propionitrile at 100 µg/mL, acrolein and ketones at 125 µg/mL, tetrahydrofuran at 350 µg/mL, 1,4-dioxane and isobutyl alcohol at 1250 µg/mL) through the septum of the 44 mL sample vial. Additionally, for manual injections these standards may be prepared in a 5 mL gas tight syringe and spiked with the appropriate volumes to achieve the analyte concentrations specified above.

7.11. Fortification Solutions for Internal Standard and Surrogates - Two separate fortification solutions are required to prepare laboratory reagent blanks, standards and to fortify each sample. A fortification solution is prepared containing fluorobenzene, chlorobenzene-d_5 and 1,4-Dichlorobenzene-d_4 (internal standards) in methanol. A separate fortification solution is prepared containing 1,2-dichlorobenzene-d_4, BFB, 1,2-Dichloroethane-d_4, Toluene-d_8 (surrogates) in methanol. The internal standards are present in each 5 ml sample, blank or standard at a concentration of 50 µg/L (Low Water Analysis at 5 µg/L). Surrogate compounds are at the same concentration as the analytes in the initial calibration standards. In all other standards, samples and blanks the surrogate compounds are at a concentration of 50 µg/L (Low Water Analysis at 5 µg/L).

8.0 SAMPLE HANDLING AND PRESERVATION

8.1. Sample collection - Sample collection for aqueous samples is described in method 5030. Sample collection for solid samples is described in method 5035.

8.2. Preservation - Sample preservation for aqueous samples is described in method 5030. Sample preservation for solid samples is described in method 5035.

8.3. Storage - Samples are analyzed within fourteen days of collection. Other holding times may be selected by the client to conform to local regulatory requirements (i.e., NYS samples must be analyzed within 7 days of receipt). Aqueous samples that have not been preserved are analyzed within 7 days of collection. Samples are stored at 4°C ± 2°C in a storage area free of organic solvent vapors and direct or intense light. Upon receipt all samples are screened by the laboratory and the pH of the liquid sample documented on the screening request worksheet.

9.0 QUALITY CONTROL

9.1. 4-Bromofluorbenzene - Prior to the acquisition of a calibration curve or the analysis of samples, a 2 µL aliquot of BFB (25 µg/mL) is manually introduced into the GC. If the spectrum does not meet all criteria in Table 2, another BFB tune is injected into the instrument. If the second BFB tune fails the criteria in Table 2 (section 18.0), the MS should be retuned and adjusted to meet all criteria before proceeding with the calibration or the analysis.

9.2. Method detection limits (MDLs) are determined annually in accordance with the method described in 40 CFR, Part 136, Appendix B. The results of these studies are kept on file by the QA Manager. Typical values for most analytes are in the range of 0.5 to 1.0 µg/L for aqueous samples (Method 5030 and Method 8260). For soil samples, typical values for most analytes are in the range of 1.5 to 3.5 µg/L (Method 5035 and Method 8260). The mean accuracy should be 80 - 120% and the precision (%RSD) for each analyte should be ≤20% for all compounds. For the low water analysis, the analytes are in the range of 0.1 to 0.5 µg/L for most compounds (Method 5030 and Method 8260)

9.3. Initial Calibration Verification - An ICV must be run following the acquisition of the five-point initial calibration. The ICV is prepared from a source external to the laboratory and independent from the source of the initial calibration standards. The compounds should be at a concentration of 50 µg/L (propionitrile at 200 µg/L, tetrahydrofuran at 500 µg/L, 1,4-dioxane and isobutyl alcohol at 2500 µg/L). The ICV recovery limits are shown in Table 6. For the low water analysis, the compounds should be at a concentration of 10 µg/L (propionitrile at 40 µg/L, acrolein and ketones at 50 µg/L, tetrahydrofuran at 140 µg/L, 1,4-dioxane and isobutyl alcohol at 500 µg/L).

9.4. Method Blank - One blank must be run with every batch of samples after the calibration standard. A 5.0 mL aliquot of laboratory blank reagent water must be analyzed prior to any aqueous samples. 5.0 grams of clean sand must be analyzed prior to any solid samples. For soil samples extracted following Method 5035, the method blank is prepared in an aliquot of sodium bisulfate (see Section 7.8). An acceptable blank must not contain any volatile target analytes at concentrations greater than their reporting limits with the following exceptions: Methylene Chloride, acetone and 2-butanone, which must be less than or equal to five times (5X) their reporting limits. If the method blank exceeds these criteria, the analytical system may be out of control. The source of the contamination must be investigated and appropriate corrective measures must be taken and documented before further sample analysis proceeds.

9.5. Laboratory Control Sample - A laboratory control sample should be included with each analytical batch. The compounds should be at a concentration of 50 µg/L (propionitrile at 200 µg/L, tetrahydrofuran at 500 µg/L, 1,4-dioxane and isobutyl alcohol at 2500 µg/L). The LCS recovery limits are shown in Table 6. For the low water analysis, the compounds should be at a concentration of 10 µg/L (propionitrile at 40 µg/L, acrolein and ketones at 50 µg/L, tetrahydrofuran at 140 µg/L, 1,4-dioxane and isobutyl alcohol at 500 µg/L).

9.6. Laboratory Fortified Matrix Spike and Laboratory Fortified Matrix Spike Duplicate (MS/MSD) - The laboratory will analyze one MS/MSD for each client sample delivery group (20 samples). The MS/MSD will be selected by the laboratory if a client has not specified the sample to be analyzed as the MS/MSD. The MS/MSD will be prepared to contain the analytes at a concentration of 50 µg/L (propionitrile at 200 µg/L, tetrahydrofuran at 500 µg/L, 1,4-dioxane and isobutyl alcohol at 2500 µg/L). For the low water analysis, the MS/MSD will be prepared so as to contain the analytes at a concentration of 10 µg/L (propionitrile at 40 µg/L, acrolein and ketones at 50 µg/L,

tetrahydrofuran at 140 µg/L, 1,4-dioxane and isobutyl alcohol at 500 µg/L). The MS/MSD recovery limits are shown in Table 6. The requirement of analyzing a duplicate sample is satisfied by analyzing both the MS and MSD.

9.7. Surrogates/Internal Standards - Four compounds are used as surrogates; 1,2-Dichlorethane-d_4, 1,2-Dichlorobenzene-d_4, 4-Bromofluorobenzene, and Toluene-d_8. Three compounds are used as internal standards fluorobenzene, chlorobenzene-d_5 and 1,4-Dichlorobenzene-d_4. Surrogate and internal standard concentrations in the purge vessel are 50 µg/L (Low water analysis at 5 µg/L). Table 4 shows the recommended surrogate recoveries for water samples. Table 5 shows the recommended surrogate recoveries for soil samples.

10.0 CALIBRATION AND STANDARDIZATION

10.1. BFB - The ion abundances shown in Table 2 must be met before analysis of calibration standards may proceed.

10.2. Initial Calibration - The five concentrations for the initial calibration are 5, 20, 50, 100, and 200 µg/L (propionitrile at 20, 80, 200, 400 and 800 µg/L, tetrahydrofuran at 50, 200, 500, 1000 and 2000 µg/L, 1,4-dioxane and isobutyl alcohol at 250, 1000, 2500, 5000 and 10,000 µg/L). For the low water analysis, the five concentrations for the initial calibration are 1, 5, 10, 25 and 50 µg/L (propionitrile at 4, 20, 40, 100 and 200 µg/L, acrolein and ketones at 5, 25, 50, 125 and 250 µg/L, tetrahydrofuran at 14, 70, 140, 350 and 700 µg/L, 1,4-dioxane and isobutyl alcohol at 50, 250, 500, 1250 and 2500 µg/L). A response factor (RF) is calculated for each analyte and/or isomer pair for each calibration solution using the appropriate internal standard. The calculation is performed as follows:

$$RF = \frac{(A_x)(Q_{is})}{(A_{is})(Q_x)}$$

Where:

A_x = integrated abundance of the quantitation ion of the analyte
A_{is} = integrated abundance of the quantitation ion of the internal standard
Q_x = quantity of analyte purged in nanograms or concentration units
Q_{is} = quantity of internal standard purged in ng or concentration units

10.3. For each analyte and surrogate, calculate the mean response factor from analyses of the calibration solutions. Calculate the standard deviation (SD) and relative standard deviation (RSD) from each mean (M).

$$RSD = 100\frac{SD}{M}$$

System performance check compounds (SPCCs) must meet the required minimum average response factor (RRF) shown in Table 3. The %RSD average of all analytes must be ≤ 15%. In addition, individual calibration check compounds (CCCs) must have

an RSD ≤ 30%. If this criteria is not met maintenance is performed on the instrument and/or a new calibration curve is acquired. Alternatively, if the CCC criteria has been met and the %RSD for one or more analytes exceeds the 15%, the initial calibration may still be acceptable if the following conditions are met as specified in method 8000B: the mean of the RSD values for all analytes in the calibration is less than or equal to 15%. The mean RSD is calculated by summing the RSD value for each analyte and dividing by the total number of analytes. The mean RSD criterion applies to all analytes in the standards, regardless of whether or not they are of interest for a specific project. The data user must be provided with either a summary of the IC data or a specific list of those compounds for which the RSD exceeded 15% and the results of the mean RSD calculation. Caution: the analyst and the data user must be aware that the use of this approach will lead to greater uncertainty for those analytes for which the RSD is greater than 15%. Review quality controls carefully, with particular attention to the LCS to determine if the calibration linearity poses a significant concern. If this approach is not acceptable for a particular project objective, then the analyst may employ one of the other calibration approaches (Linear calibration using a least squares regression to non-linear calibration) or adjust the instrument operating conditions.

10.4. Continuing Calibration Verification - Verify the BFB MS tune and perform a continuing calibration verification at the beginning of each 12-hr work shift. The concentration of the CCV is 50 µg/L (propionitrile at 200 µg/L, tetrahydrofuran at 500 µg/L, 1,4-dioxane at 2500 µg/L and isobutyl alcohol at 2500 µg/L). For the low water analysis, the concentration of the CCV is 10 µg/L (propionitrile 40 µg/L, acrolein and ketones 50 µg/L, tetrahydrofuran at 140 µg/L, and 1,4-dioxane and isobutyl alcohol at 500 µg/L). The RF is calculated for each analyte and surrogate compound from the data measured in the continuing calibration check. System performance check compounds must meet the required minimum average response factor (RRF) shown in Table 3. The percent difference is calculated using the following equation:

$$\%\,Difference = \frac{RF_v - RF}{RF}\ (100)$$

Where:
RF_v = Response Factor from the analyses of the verification standard
RF = Mean Response Factor from the initial calibration

The percent difference for each CCC should be ≤ 20%. In addition, the internal standard retention time should not change by more than 30 seconds from the mid-point standard level of the most recent initial curve sequence. The integrated areas of the internal standards in the calibration verification standard should not change by more than a factor of two (-50% to +100%) from that in the mid-point standard level of the most recent initial calibration sequence. If the above criteria are not met maintenance is performed on the instrument and/or a new calibration curve is acquired. Alternatively, in keeping with the approach described for the IC, if the CCC and SPCC criteria have been met and if the average of the responses for all analytes is within 15%, then the calibration has been verified. If the calibration still does not meet the 15% limit (based on either each compound or the average across all compounds), check the instrument operating conditions, and if necessary inject another aliquot of the calibration verification

standard. If the response for the analyte is still not within ± 15%, then a new IC must be prepared.

11.0 PROCEDURE

11.1. Sample Introduction and Purging - See preparation and introduction Methods 5030 and 5035.

11.2. Gas Chromatography/Mass Spectrometry - Data is acquired and stored over the nominal mass range 35-300 with a total cycle time (including scan overhead time) of two seconds or less. The cycle time is adjusted to measure five or more spectra during the elution of each GC peak. A multi-stage temperature ramp is used to separate the components of interest for this analysis. A typical GC temperature program is described below.

Initial temperature 40° C, initial time 4 min.
Ramp1: 7° C/min. to 100° C, hold for 1 min.
Ramp2: 4.2° C/min. to 120° C, hold for 0 min.
Ramp3: 28° C/min. to 220° C, hold for 2.1 min.

Instrument control and acquisition parameters are defined on the ChemStation software for each instrument.

11.3. Identification of Analytes - A sample is identified by comparison of its mass spectrum (after background subtraction) to a reference spectrum in the user-created data base. The GC retention time for each analyte should be within ± 0.5 minutes of the midpoint standard's retention time in the initial calibration curve.

11.3.1. In general, all ions that are present above 10% relative abundance in the mass spectrum of the standard should be present in the mass spectrum of the sample component and should agree within absolute 20%. For example, if an ion has a relative abundance of 30% in the standard spectrum, its abundance in the sample spectrum should be in the range of 10-50%. Some ions, particularly the molecular ion, are of special importance, and should be evaluated even if they are below 10% relative abundance.

11.3.2. Identification requires expert judgment when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When GC peaks obviously represent more than one sample component (i.e., broadened peak with shoulder(s) or valley between two or more maxima), appropriate analyte spectra and background spectra can be selected by examining plots of characteristic ions for tentatively identified components. When analytes coelute (i.e., only one GC peak is apparent), the identification criteria can be met but each analyte spectrum will contain extraneous ions contributed by the coeluting compound. Because purgeable organic compounds are relatively small molecules and produce comparatively simple mass spectra, this is not a significant problem for most method analytes.

11.3.3. Structural isomers that produce very similar mass spectra can be explicitly identified only if they have sufficiently different GC retention times. Acceptable resolution is achieved if the height of the valley between two peaks is less than 25% of the average height of the two peaks. Otherwise, structural isomers are identified as isomeric pairs. Two of the three isomeric xylenes are examples of structural isomers that are not resolved on the capillary column. These groups of isomers will be reported as isomeric pairs.

11.3.4. Methylene chloride, acetone, carbon disulfide, and other background components appear in variable quantities in laboratory and field reagent blanks and generally cannot be accurately measured. Subtraction of the concentration in the blank from the concentration in the sample is not performed because the concentration of the background in the blank is highly variable.

12.0 CALCULATIONS

12.1. Concentrations of Unknowns –

Method 8260B does not include reporting of tentatively identified compounds (TIC). However, reporting of up to 10 TIC's whose peak heights are ≥ 10% of the nearest internal standard may be requested or ≥ 40% of the nearest internal standard may be requested for low concentration analyses. Concentrations are calculated using the following formula using an assumed response factor (RF) of 1:

$$C_{(x)} = \frac{C_{(IS)} * A_{(x)}}{A_{(IS)}} * DF$$

Where:
$C_{(x)}$= Concentration of Unknown (µg/L).
$C_{(IS)}$= Concentration of internal standard (µg/L).
DF = Dilution Factor
$A_{(x)}$ = Area of Unknown
$A_{(IS)}$= Area of associated internal standard.

12.2. Concentrations of Calibrated Compounds:

$$C_{(x)} = \frac{A_{(x)} * C_{(IS)}}{A_{(IS)} * \overline{RRF}} * DF$$

Where:
$C_{(x)}$ = Concentration of compound (µg/L)
$C_{(IS)}$ = Concentration of associated internal standard (µg/L).
DF = Dilution Factor.
$A_{(IS)}$ = Area of quantitation ion for associated internal standard.
$A_{(x)}$ = Area of quantitation ion for compound.

$\overline{RRF}$ = Average Relative Response Factor from five-point initial calibration.

12.3. Calculation of Recovery - Calculate the recovery of each spiked analyte in the MS/MSD, LCS and ICV by the following equation:

$$\text{Recovery} = \%R = \frac{C_s - C_u}{C_n} \text{ X } 100$$

Where:
Cs = Measured concentration of the spiked sample aliquot
Cu = Measured concentration of the unspiked sample aliquot (use 0 for LCS and ICV)
Cn = Nominal (theoretical) concentration increase that results from spiking the sample, or the nominal concentration of the spike aliquot (for LCS and ICV)

12.4. Calculation of Precision - Precision is estimated from the relative percent difference (RPD) of the concentrations (not the recoveries) measured for matrix spike/ matrix spike duplicate pairs, or for duplicate analyses of unspiked samples. The RPD is calculated according to the following equation below.

$$RPD = \frac{[C_1 - C_2]}{\left(\frac{C_1 + C_2}{2}\right)} X\ 100$$

Where:
C1 = Measured concentration of the first sample aliquot
C2 = Measured concentration of the second sample aliquot

12.5. Data Reporting - Based on the mass spectra, it is appropriate to report values between the MDL and the RL. In this region, an analyte can be qualitatively detected, but not accurately quantified. Any data point reported in this region is flagged with a "J" qualifier. STL reports sample specific RL's. Sample specific RL's are derived by taking into account various sample specific data, which can include the amount of the sample subject to testing, % moisture, dilution factor, interferences and the base RL's for the analysis.

12.5.1. Reporting qualifiers are as follows:

B = Analyte is found in the associated method blank as well as the sample
D = Compound is identified in an analysis at a secondary dilution factor
E = Compound quantitation is above the instrument's calibration range for this analysis
J = Indicates an estimated quantitation value
U = Compound was analyzed for but not detected
X = The reported compound is a suspected laboratory contaminant
Y = an additional qualifier which will be defined at the time of use by the data reviewer
Z = The reported result is based on the combined responses from coeluting compounds

12.5.2. Data Package Definitions - Three levels of reporting are available. The difference between these levels has nothing to do with the quality of the work being performed, only how it is presented.

- Level 2: A level 2 data package consists of sample results only, and may be available as either an Analytical Report or in a format similar to the OLM Form 1A's.
- Level 3: A level 3 data package consists of sample, CLP-like forms with Quality Control results.
- Level 4: A level 4 data package consists of a full set of RAS forms, and all supporting documentation.

Electronic-Diskette available upon request.

13.0 DATA ASSESSMENT, CRITERIA & CORRECTIVE ACTION

13.1. Data is initially reviewed by the analyst in the lab and stamped as such. Following this, the data is secondarily reviewed by QC personnel before being put into its final data package form (where the data is thirdly reviewed before being sent to the client).

13.2. Data that is out of control is marked as such and slated for re-analysis. Any corrective action undertaken is documented on a corrective action form (detailing the client information, problem, investigation findings and solution). This form is kept together with the project. Refer to Table 7 for a list of possible corrective actions.

13.3. Generally, any data that is out of control is considered unusable. There are, however, cases in which the laboratory supervisor will be made aware of the issue and, if the data is used, it will be thoroughly narrative noted. Refer to Table 7 for a list of possible corrective actions.

14.0 METHOD PERFORMANCE

14.1. Laboratory accuracy and precision data were obtained for the method analytes using laboratory control spikes. The analytes were at a concentration of 5 µg/L (propionitrile at 20 µg/L, tetrahydrofuran at 50 µg/L, 1,4-Dioxane and isobutyl alcohol at 250 µg/L) for the procedural combination of Methods 5035 and 8260. The analytes were at a concentration of 2.5 µg/L (propionitrile at 7.5 µg/L, tetrahydrofuran at 25 µg/L, 1,4-Dioxane and isobutyl alcohol at 125 µg/L) for the procedural combination of Methods 5030 and 8260. For the low water analysis, the analytes were at a concentration of 0.5µg/L (propionitrile 2.0 µg/L, acrolein and ketones 2.5 µg/L, tetrahydrofuran at 7.0 µg/L, and 1,4-dioxane and isobutyl alcohol at 25 µg/L Results were obtained using the analytical instrumentation described in section 6.

14.2. With this data, method detection limits were calculated using the formula (3):

$$MDL = S\, t_{(n-1,\ 1\text{-alpha} = 0.99)}$$

Where:
$t_{(n-1,\ 1\text{-alpha} = 0.99)}$ = Student's t value for the 99% confidence level with n-1 degrees of freedom
n = number of replicates
S = the standard deviation of the replicate analyses

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1. Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The USEPA has established a prevention hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the agency recommends recycling as the next best option.

15.2. The quantity of chemical purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

15.3. For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction", available from the American Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036; (202) 872-4477.

15.4. The USEPA requires that laboratory waste management practices conducted be consistent with all applicable rules and regulations. Excess reagents, samples, and method process wastes should be characterized and disposed of in an acceptable manner. The Agency urges laboratories to protect the air, water and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult the "Waste Management Manual for Laboratory Personnel", available from the American Chemical Society at the address listed in Section 15.3.

16.0 REFERENCES

16.1. Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996.

17.0 TABLES, DIAGRAMS, FLOWCHARTS

Table 1: Analytes, Chemical Abstract Services Numbers and Reporting Limits (RL)

Analyte	CAS No.	RL (µg/L or µg/Kg)	Low Water RL (µg/L)	Methanol Extracts* RL (µg/Kg)
Acetone	67-64-1	5.0	5.0	620
Acrolein	107-02-8	5.0	5.0	620
Acrylonitrile	107-13-1	5.0	1.0	620
Allyl Chloride	107-05-1	5.0	1.0	620
Benzene	71-43-2	5.0	1.0	620
Bromobenzene	108-86-1	5.0	1.0	620
Bromochloromethane	74-97-5	5.0	1.0	620
Bromodichloromethane	75-27-4	5.0	1.0	620
Bromoform (SPCC)	75-25-2	5.0	1.0	620
Bromomethane	74-83-9	5.0	1.0	620
2-Butanone	78-93-3	5.0	5.0	620
n-Butylbenzene	104-51-8	5.0	1.0	620
sec-Butylbenzene	135-98-8	5.0	1.0	620
tert-Butylbenzene	98-06-6	5.0	1.0	620
Carbon Disulfide	75-15-0	5.0	1.0	620
Carbon Tetrachloride	56-23-5	5.0	1.0	620
Chlorobenzene (SPCC)	108-90-7	5.0	1.0	620
Chloroethane	75-00-3	5.0	1.0	620
2-Chloroethyl Vinyl Ether	110-75-8	5.0	1.0	620
Chloroform (CCC)	67-66-3	5.0	1.0	620
Chloromethane (SPCC)	74-87-3	5.0	1.0	620
Chloroprene	126-99-8	5.0	1.0	620
2-Chlorotoluene	95-49-8	5.0	1.0	620
4-Chlorotoluene	106-43-4	5.0	1.0	620
1,2-Dibromo-3-chloropropane	96-12-8	5.0	1.0	620

Analyte	CAS No.	RL (µg/L or µg/Kg)	Low Water RL (µg/L)	Methanol Extracts* RL (µg/Kg)
Dibromochloromethane	124-48-1	5.0	1.0	620
1,2-Dibromoethane	106-93-4	5.0	1.0	620
Dibromomethane	74-95-3	5.0	1.0	620
1,2-Dichlorobenzene	95-50-1	5.0	1.0	620
1,3-Dichlorobenzene	541-73-1	5.0	1.0	620
1,4-Dichlorobenzene	106-46-7	5.0	1.0	620
cis-1,4-Dichloro-2-butene	1476-11-5	5.0	1.0	620
trans-1,4 Dichloro-2-butene	110-57-6	5.0	1.0	620
Dichlorodifluoromethane	75-71-8	5.0	1.0	620
1,1-Dichloroethane (SPCC)	75-34-3	5.0	1.0	620
1,2-Dichloroethane	107-06-2	5.0	1.0	620
1,1-Dichloroethene (CCC)	75-35-4	5.0	1.0	620
cis-1,2-Dichloroethene	156-59-2	5.0	1.0	620
trans-1,2-Dichloroethene	156-60-5	5.0	1.0	620
1,2-Dichloropropane (CCC)	78-87-5	5.0	1.0	620
1,3-Dichloropropane	142-28-9	5.0	1.0	620
2,2-Dichloropropane	594-20-7	5.0	1.0	620
1,1-Dichloropropene	563-58-6	5.0	1.0	620
cis-1,3-Dichloropropene	10061-01-5	5.0	1.0	620
trans-1,3-Dichloropropene	10061-02-6	5.0	1.0	620
1,4-Dioxane	123-91-1	250	50	31,000
Ethyl Methacrylate	97-63-2	5.0	1.0	620
Ethylbenzene (CCC)	100-41-4	5.0	1.0	620
Freon TF	76-13-1	5.0	1.0	620
Hexachlorobutadiene	87-68-3	5.0	1.0	620
2-Hexanone	591-78-6	5.0	5.0	620

Analyte	CAS No.	RL (µg/L or µg/Kg)	Low Water RL (µg/L)	Methanol Extracts* RL (µg/Kg)
Isobutyl alcohol	78-83-1	250	50	31,000
Isopropylbenzene	98-82-8	5.0	1.0	620
4-Isopropyltoluene	99-87-6	5.0	1.0	620
Methacrylonitrile	126-98-7	5.0	1.0	620
Methyl Iodide	74-88-4	5.0	1.0	620
Methyl Methacrylate	80-62-6	5.0	1.0	620
4-Methyl-2-pentanone	108-10-1	5.0	5.0	620
Methyl-t-Butyl Ether	1634-04-4	5.0	1.0	620
Methylene Chloride	75-09-2	5.0	1.0	620
Naphthalene	91-20-3	5.0	1.0	620
Propionitrile	107-12-0	20	4.0	2,500
n-Propylbenzene	103-65-1	5.0	1.0	620
Styrene	100-42-5	5.0	1.0	620
1,1,1,2-Tetrachloroethane	630-20-6	5.0	1.0	620
1,1,2,2-Tetrachloroethane (CPCC)	79-34-5	5.0	1.0	620
Tetrachloroethene	127-18-4	5.0	1.0	620
Tetrahydrofuran	109-99-9	50	14	6,200
Toluene (CCC)	108-88-3	5.0	1.0	620
1,2,3-Trichlorobenzene	87-61-6	5.0	1.0	620
1,2,4-Trichlorobenzene	120-82-1	5.0	1.0	620
1,2,4-Trimethylbenzene	95-63-6	5.0	1.0	620
1,3,5-Trimethylbenzene	108-67-8	5.0	1.0	620
1,1,1-Trichloroethane	71-55-6	5.0	1.0	620
1,1,2-Trichloroethane	79-00-5	5.0	1.0	620
Trichloroethene	79-01-6	5.0	1.0	620
Trichlorofluoromethane	75-69-4	5.0	1.0	620

Analyte	CAS No.	RL (µg/L or µg/Kg)	Low Water RL (µg/L)	Methanol Extracts* RL (µg/Kg)
1,2,3-Trichloropropane	96-18-4	5.0	1.0	620
Vinyl Acetate	108-05-4	5.0	1.0	620
Vinyl Chloride (CCC)	75-01-4	5.0	1.0	620
Xylene (m,p)	1330-20-7	5.0	2.0	620
Xylene (o)	95-47-6	5.0	1.0	620

(SPCC) System Performance Check Compounds, (CCC) Calibration Check Compounds
*Methanol extracts 4g to 10 mL.

Table 2: BFB Criteria

BFB Key Ions and Ion Abundance Criteria	
Mass	Ion Abundance Criteria
50	15.0-40.0 percent of mass 95
75	30.0-60.0 percent of mass 95
95	base peak, 100 percent relative abundance
96	5.0-9.0 percent of mass 95
173	less than 2.0 percent of mass 174
174	>50.0 percent of mass 95
175	5.0-9.0 percent of mass 174
176	95.0-101.0 percent of mass 174
177	5.0-9.0 percent of mass 176

Table 3: Calibration Criteria

Compound	Minimum RRF	Maximum %RSD	Maximum %D
Acetone	0.01	15	20
Acrolein	0.01	15	20
Acrylonitrile	0.01	15	20
Allyl Chloride	0.01	15	20
Benzene	0.01	15	20
Bromochloromethane	0.01	15	20
Bromodichloromethane	0.01	15	20
Bromoform (SPCC)	0.1	15	20
Bromomethane	0.01	15	20
2-Butanone	0.01	15	20
Carbon Disulfide	0.01	15	20
Carbon Tetrachloride	0.01	15	20
Chlorobenzene (SPCC)	0.30	15	20
Chloroethane	0.01	15	20
2-Chloroethyl Vinyl Ether	0.01	15	20
Chloroform (CCC)	0.01	30	20
Chloromethane (SPCC)	0.10	15	20
Chloroprene	0.01	15	20
2-Chlorotoluene	0.01	15	20
4-Chlorotoluene	0.01	15	20
1,2-Dibromo-3-chloropropane	0.01	15	20
Dibromochloromethane	0.01	15	20
1,2-Dibromoethane	0.01	15	20
Dibromomethane	0.01	15	20
1,2-Dichlorobenzene	0.01	15	20
1,3-Dichlorobenzene	0.01	15	20

Compound	Minimum RRF	Maximum %RSD	Maximum %D
1,4-Dichlorobenzene	0.01	15	20
cis-1,4-Dichloro-2-butene	0.01	15	20
trans-1,4 Dichloro-2-butene	0.01	15	20
Dichlorodifluoromethane	0.01	15	20
1,1-Dichloroethane (SPCC)	0.1	15	20
1,2-Dichloroethane	0.01	15	20
1,1-Dichloroethene (CCC)	0.01	30	20
cis-1,2-Dichloroethene	0.01	15	20
trans-1,2-Dichloroethene	0.01	15	20
1,2-Dichloropropane (CCC)	0.01	30	20
1,3-Dichloropropane	0.01	15	20
2,2-Dichloropropane	0.01	15	20
1,1-Dichloropropene	0.01	15	20
cis-1,3-Dichloropropene	0.01	15	20
trans-1,3-Dichloropropene	0.01	15	20
1,4-Dioxane	0.01	15	20
Ethyl Methacrylate	0.01	15	20
Ethylbenzene (CCC)	0.01	30	20
Freon TF	0.01	15	20
Hexachlorobutadiene	0.01	15	20
2-Hexanone	0.01	15	20
Isobutyl alcohol	0.01	15	20
Isopropylbenzene	0.01	15	20
4-Isopropyltoluene	0.01	15	20
Methacrylonitrile	0.01	15	20
Methyl Iodide	0.01	15	20
Methyl Methacrylate	0.01	15	20

Compound	Minimum RRF	Maximum %RSD	Maximum %D
4-Methyl-2-pentanone	0.01	15	20
Methyl-t-Butyl Ether	0.01	15	20
Methylene Chloride	0.01	15	20
Naphthalene	0.01	15	20
Propionitrile	0.01	15	20
n-Propylbenzene	0.01	15	20
Styrene	0.01	15	20
1,1,1,2-Tetrachloroethane	0.01	15	20
1,1,2,2-Tetrachloroethane (SPCC)	0.3	15	20
Tetrachloroethene	0.01	15	20
Tetrahydrofuran	0.01	15	20
Toluene (CCC)	0.01	30	20
1,2,3-Trichlorobenzene	0.01	15	20
1,2,4-Trimethylbenzene	0.01	15	20
1,3,5-Trimethylbenzene	0.01	15	20
1,2,4-Trichlorobenzene	0.01	15	20
1,1,1-Trichloroethane	0.01	15	20
1,1,2-Trichloroethane	0.01	15	20
Trichloroethene	0.01	15	20
Trichlorofluoromethane	0.01	15	20
1,2,3-Trichloropropane	0.01	15	20
Vinyl Acetate	0.01	15	20
Vinyl Chloride (CCC)	0.01	30	20
Xylene (m,p)	0.01	15	20
Xylene (o)	0.01	15	20

(SPCC) System Performance Check Compound, (CCC) Calibration Check Compounds

Table 4: Surrogate Recoveries Water

Recoveries based on charted control limits.

Surrogate Recovery Requirements (%Recovery)	
4-Bromofluorobenzene	72-122
1,2-Dichlorobenzene-d4	69-124
1,2-Dichloroethane-d4	72-141
Toluene-d8	88-110

Table 5: Surrogate Recoveries Soil

Recoveries based on charted control limits

Surrogate Recovery Requirements (%Recovery)	
4-Bromofluorobenzene	74-121
1,2-Dichlorobenzene-d4	80-120
1,2-Dichloroethane-d4	80-120
Toluene-d8	81-117

Table 6: Control Limits

Recoveries based on single laboratory control chart data from Method 8260B.

Compound	**MS Recovery Limit (%)**	**% RPD**	**LCS/ICV Recovery Limit (%)**
Acetone	60-140	40	60-140
Acrolein	60-140	40	60-140
Acrylonitrile	60-140	40	60-140
Allyl Chloride	60-140	40	60-140
Benzene	78-116	40	78-116
Bromobenzene	84-116	40	84-116
Bromochloromethane	73-107	40	73-107
Bromodichloromethane	78-112	40	78-112

Compound	MS Recovery Limit (%)	% RPD	LCS/ICV Recovery Limit (%)
Bromoform	82-120	40	82-120
Bromomethane	72-118	40	72-118
2-Butanone	60-140	40	60-140
n-Butylbenzene	77-123	40	77-123
sec-Butylbenzene	77-123	40	77-123
tert-Butylbenzene	80-124	40	80-124
Carbon Disulfide	60-140	40	60-140
Carbon Tetrachloride	62-106	40	62-106
Chlorobenzene	81-115	40	81-115
Chloroethane	65-113	40	65-113
2-Chloroethyl Vinyl Ether	60-140	40	60-140
Chloroform	74-106	40	74-106
Chloromethane	68-118	40	68-118
Chloroprene	60-140	40	60-140
2-Chlorotoluene	73-107	40	73-107
4-Chlorotoluene	74-124	40	74-124
1,2-Dibromo-3-chloropropane	33-132	40	33-132
Dibromochloromethane	72-112	40	72-112
1,2-Dibromoethane	90-114	40	90-114
Dibromomethane	83-117	40	83-117
1,2-Dichlorobenzene	76-110	40	76-110
1,3-Dichlorobenzene	79-119	40	79-119
1,4-Dichlorobenzene	83-123	40	83-123
cis-1,4-Dichloro-2-butene	60-140	40	60-140
trans-1,4 Dichloro-2-butene	60-140	40	60-140
Dichlorodifluoromethane	78-116	40	78-116
1,1-Dichloroethane	81-111	40	81-111

Compound	MS Recovery Limit (%)	% RPD	LCS/ICV Recovery Limit (%)
1,2-Dichloroethane	80-110	40	80-110
1,1-Dichloroethene	75-113	40	75-113
cis-1,2-Dichloroethene	81-121	40	81-121
trans-1,2-Dichloroethene	77-109	40	77-109
1,2-Dichloropropane	79-115	40	79-115
2,2-Dichloropropane	42-130	40	42-130
1,3-Dichloropropane	79-113	40	79-113
1,1-Dichloropropene	72-124	40	72-124
cis-1,3-Dichloropropene	60-140	40	60-140
trans-1,3-Dichloropropene	60-140	40	60-140
1,4-Dioxane	60-140	40	60-140
Ethyl Methacrylate	60-140	40	60-140
Ethylbenzene	74-124	40	74-124
Freon TF	60-140	40	60-140
Hexachlorobutadiene	80-120	40	80-120
2-Hexanone	60-140	40	60-140
Isobutyl alcohol	60-140	40	60-140
Isopropylbenzene	78-124	40	78-124
4-Isopropyltoluene	79-119	40	79-119
Methacrylonitrile	60-140	40	60-140
Methyl Iodide	60-140	40	60-140
Methyl Methacrylate	60-140	40	60-140
4-Methyl-2-pentanone	60-140	40	60-140
Methyl-t-Butyl Ether	60-140	40	60-140
Methylene Chloride	80-110	40	80-110
Naphthalene	78-130	40	78-130
Propionitrile	60-140	40	60-140

Compound	MS Recovery Limit (%)	% RPD	LCS/ICV Recovery Limit (%)
n-Propylbenzene	83-117	40	83-117
Styrene	80-124	40	80-124
1,1,1,2-Tetrachloroethane	72-108	40	72-108
1,1,2,2-Tetrachloroethane	74-108	40	74-108
Tetrachloroethene	71-107	40	71-107
Tetrahydrofuran	60-140	40	60-140
Toluene	78-126	40	78-126
1,2,3-Trichlorobenzene	81-137	40	81-137
1,2,4-Trichlorobenzene	81-135	40	81-135
1,1,1-Trichloroethane	74-122	40	74-122
1,1,2-Trichloroethane	81-126	40	81-126
Trichloroethene	70-109	40	70-109
Trichlorofluoromethane	67-111	40	67-111
1,2,3-Trichloropropane	81-137	40	81-137
1,2,4-Trimethylbenzene	75-123	40	75-123
1,3,5-Trimethylbenzene	72-112	40	72-112
Vinyl Acetate	60-140	40	60-140
Vinyl Chloride	78-118	40	78-118
Xylene (m,p)	78-116	40	78-116
Xylene (o)	81-125	40	81-125

Table 7: 8260 Volatile Organic Analytical Run Sequence and Corrective Action

Quality Control Criteria	Frequency	Acceptance	Corrective Action
BFB	12 hour	Criteria Table 2	Reshoot, Retune
ICAL: 5, 20, 50, 100, 200 µg/L (Low water 1, 5, 10, 25, 50 µg/L)	As Required	minimum RF for SPCCs maximum %RSD for CCCs and average %RSD of all analytes must be ≤ 15%	System check, Mix new standards, Recalibrate, Reanalyze
ICV/LCS (alternative source)	after every ICAL	minimum RF for SPCCs %Difference each CCC ≤20% Evaluate as an LCS	System Check, Recalibrate
BFB	12 hour	Criteria Table 2	Reshoot, Retune
CCV	beginning of each 12 hour window	minimum RF for SPCCs %Difference each CCC ≤20%	System Check, Recalibrate
LCS	every analytical batch	Control Limits Table 6	Check Std, Check Quantitation, Evaluate MS/MSD, reanalyze analytical batch.
Method Blank	every analytical batch	Targets < Reporting Limits	Check for contamination, Reanalyze, correct as required
Samples	Until 12 hour window is closed	Results < Highest Calibration Std.; Surrogate and Internal Std. Recovery per method	Dilute and reanalyze. If surrogate/internal std. recovery fails, reanalyze based on technical judgement.
Matrix Spike/Matrix Spike Duplicate	every analytical batch	Control Limits Table 6	Reanalyze if analytical problem. Evaluate LCS

Appendix A: Terms & Definitions

Batch: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation/digestion batch is composed of one to 20 environmental samples of similar matrix, meeting the above criteria.

Calibration Check Compounds (CCCs): Selective analytes from the compound list that are used to evaluate the calibration from the standpoint of the integrity of the system. High variability for these compounds may be indicative of system leaks or reactive sites on the column. These compounds are 1,1 -dichloroethene, chloroform, 1,2-dichloropropane, toluene, ethylbenzene, and vinyl chloride.

Calibration Curve: the graphical relationship between the known values or a series of calibration standards and their instrument response.

Calibration Standard (CAL): A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

Continuing Calibration Verification (CCV): a single or multi-parameter calibration standard used to verify the stability of the method over time. Usually from the same source as the calibration curve.

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Initial Calibration: Analysis of analytical standards for a series of different specified concentrations used to define the quantitative response, linearity and dynamic range of the instrument to target analytes.

Initial Calibration Verification (ICV): solution prepared from a separate source from that which is used to prepare the calibration curve.

Intermediate Standard: a solution made from one or more stock standards at a concentration between the stock and working standard. Intermediate standards may be certified stock standard solutions purchased from a vendor and are also known as secondary standards.

Internal Standard (IS): Non-target analyte compounds that are similar to the target analytes but are not expected to be found in environmental media (generally, isotopically labeled target analytes are used for this purpose) and are added to every standard, quality control sample, and field sample at a known concentration prior to analysis. IS responses are used as the basis for quantitation of target analytes.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s) processed simultaneously with and under the same conditions as samples through all steps of the procedure.

Matrix Duplicate (MD): duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate.

Matrix Spike (MS): a field sample to which a known amount of target analyte(s) is added.

Method Blank (MB): a blank matrix processed simultaneously with and under the same conditions as samples through all steps of the procedure. Also known as the preparation blank (PB).

Method Detection Limit (MDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs. Quantitative results are not produced in this range.

Non-conformance: an indication, judgment, or state of not having met the requirements of the relevant specification, contract or regulation.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical, and/or biological integrity of the sample.

Primary Dilution Standard Solution: A solution of several analytes prepared in the laboratory from stock standard solutions and diluted as needed to prepare calibration solutions and other needed analyte solutions.

Reporting Limit (RL): the level to which data is reported for a specific test method and/or sample. The RL must be minimally at or above the MDL.

Stock Standard: a solution made with one or more neat standards usually with a high concentration. Also known as a primary standard. Stock standards may be certified solutions purchased from a vendor.

Surrogate Analyte (SS): Non-target analyte compounds that are similar in composition and behavior to the target analytes but are not expected to be found in environmental media (often, isotopically labeled target analytes are used for this purpose) and are added to every standard, quality control sample, and field sample at a known concentration prior to preparation and/or analysis. Surrogate responses are used to evaluate the accuracy of the laboratory's performance of the analytical method in a specific sample matrix.

System Performance Check Compounds (SPCCs): Selective analytes from the compound list that are used to check compound instability and to check for degradation caused by contaminated lines or active sites in the system. These compounds are chloromethane, 1,1-dichloroethane, bromoform, chlorobenzene and 1,1,2,2-tetrachloroethane.

Trip Blank: An aliquot of reagent water or other blank matrix that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the trip blank is to determine if method analytes or other interferences are present in the field environment.

CHANGE -IN-PROGRESS ATTACHMENT (CIPA)

SOP Information:
SOP Title: Determination of Semivolatile Organic Compounds by GC/MS
SOP No: LM-MS-8270C
Revision: 3
Date Effective: 03.19.03

CIPA Date Effective: 10-20-03

Approval Signatures:

Laboratory Director: Michael F. Wheeler Ph.D. Date: 10/21/03

QA Manager: Kirstin L. McCracken Date: 10-21-03

Department Manager: Bryce Stearns by M. Wheeler Bryce E. Stearns Date 10/21/03

The following revisions or additions in BOLD TEXT have been made to the referenced SOP. These changes were implemented on the CIPA Date Effective indicated above.

Page 15-17 of 32	Table 1: Target Analyte List and Reporting Limit
Page 21 of 32	Table 4: Surrogate Recovery Limits
Page 22-23 of 32	Table5: Matrix Spike, LCS/LCSD Accuracy and Precision Limits

The reporting limit, accuracy and precision limits for the TO13 target analyte list are now given in Table 1: Routine Target Analyte List, Reporting Limit (RL) Accuracy and Precision Limits for Method TO13.

Table 1: Routine Target Analyte List, Reporting Limit (RL), Accuracy & Precicion Limits

Method TO13

Compound	CAS #	RL ug/media*	Accuracy Limit %R	Precision Limit %RPD
Naphthalene	91-20-3	10	60-120%	≤ 40
Acenaphthylene	208-96-8	10	60-120%	≤ 40
Acenaphthene	83-32-9	10	60-120%	≤ 40
Fluorene	86-73-7	10	60-120%	≤ 40
Phenanthrene	85-01-8	10	60-120%	≤ 40
Anthracene	120-12-7	10	60-120%	≤ 40
Fluoranthene	206-44-0	10	60-120%	≤ 40
Pyrene	129-00-0	10	60-120%	≤ 40
Benzo (a) anthracene	56-55-3	10	60-120%	≤ 40
Chrysene	218-01-9	10	60-120%	≤ 40
Benzo (b) fluoranthene	205-99-2	10	60-120%	≤ 40
Benzo (k) fluoranthene	207-08-9	10	60-120%	≤ 40
Benzo (a) pyrene	50-32-8	10	60-120%	≤ 40
Indeno (1,2,3-cd) pyrene	193-39-5	10	60-120%	≤ 40
Dibenz (a,h) anthracene	53-70-3	10	60-120%	≤ 40
Benzo (g,h,i) perylene	191-24-2	10	60-120%	≤ 40
Surrogates:				
Nitrobenzene-d5	4165-60-0	NA	60-120%	NA
2-Fluorobiphenyl	321-60-8	NA	60-120%	NA
Terphenyl-d14	1718-51-0	NA	60-120%	NA

**media = PUF or Wipe*

STANDARD OPERATING PROCEDURE FOR THE DETETERMINATION OF SEMIVOLATILE ORGANIC COMPOUNDS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GCMS)

Applicable Matrices: Water, Soil/Sediment, Tissue, Air
Standard Compound List and Reporting Limits: See Table 1

Approvals and Signatures

Laboratory Director: Michael F. Wheeler, Ph.D. Date: 3/19/03

QA Manager: Kirstin L. McCracken Date: 3/19/03

Organics Technical Director: Bryce E. Stearns Date: 3/19/03

1.0 SCOPE AND APPLICATION

1.1 This SOP describes the laboratory procedure for the analysis of water, soil, sediment, solid waste, tissue, and air sampling media for the determination of semivolatile organic compounds that are portioned into an organic solvent and are amenable to gas chromatography.

1.2 The following problems have been associated with the some compounds analyzed by this method: dichlorobenzidine and 4-chloroaniline may be subject to oxidative losses during solvent concentration; hexachlorocyclopentadiene is subject to thermal decomposition in the inlet of the gas chromatograph, chemical reactions in acetone solution, and photochemical decomposition; and n-nitrosodiphenylamine decomposes in the gas chromatograph inlet forming diphenylamine and, consequently, may be detected as diphenylamine.

1.3 The target compound list and reporting limits are given in Table 1.

2.0 SUMMARY OF METHOD

2.1 A one liter aliquot of a liquid sample, a 30g aliquot of a soil sample (or 1g of soil for medium level), or a PUF and XAD Resin from a TO13 sampler is spiked with a surrogate mixture, extracted with methylene chloride and concentrated following approved laboratory standard operating procedures.

2.2 An aliquot of the concentrated final extract is injected into the gas chromatograph, where it is volatilized in the injection port and swept onto the chromatographic column. A temperature program is used to separate the semivolatile compounds, and they are carried on the gas stream into the ion source of a mass spectrometer. The end of the column is positioned so the eluting compounds are ionized immediately. The ionized molecules are focused and separated according to their mass/charge (m/z) by the quadrupole analyzer. The signal is amplified by an electron multiplier and interpreted by the mass spectrometer data system to produce a total ion chromatogram and mass spectra for every data point on the chromatogram. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard with a five-point calibration curve.

2.3 This procedure is based on SW-846 Method 8270C and describes the laboratory approach to analysis for PAHs by Compendium Method TO13A.

3.0 DEFINITIONS

3.1 A list of definitions is given in Appendix A.

4.0 INTERFERENCES

4.1 Contaminants in solvents, reagents, glassware, and other sample processing hardware may cause method interferences such as discrete artifacts and/or elevated baselines in the extracted ion current profiles (EICPs). All of these materials must be routinely demonstrated to be free from interferences under the conditions of the analysis by running laboratory method blanks. Matrix interferences may be caused by contaminants that are coextracted from the sample. The extent of matrix interferences will vary considerably from source to source.

5.0 SAFETY

5.1 The toxicity or carcinogenicity of each reagent used in this procedure has not been fully

established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable. Sulfuric acid is moderately toxic and extremely irritating to skin and mucous membranes. Use reagents in a fume hood whenever possible and if eye or skin contact occurs, flush with large volumes of water. Safety glasses, gloves and protective clothing must be worn.

5.2 STL maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this procedure. Material Safety Data Sheets (MSDS) are made available to all personnel and must be read prior to performing this procedure. All laboratory personnel must also be familiar with the environmental health and safety plan described in the STL Chemical Safety Manual.

6.0 EQUIPMENT AND SUPPLIES

6.1 Instrumentation

SVOA Autosampler: HP 7673A™, CTC A200S™, or equivalent

Gas Chromatograph: Hewlett-Packard™ 5890 GC, 6890 GC

Mass Spectrometer: Hewlett-Packard™ 5971, 5972and 5973 MSD

Primary Column: Restek™ RTX-5 30m x 0.25mm ID x .25 um film thickness, or equivalent

Guard Column: Restek™ Deactivated 5m x 0.25 mm ID, or equivalent

Column unions: Restek Press-Tights™, or equivalent

Injection port liners: Single goose neck, borosilicate glass. Restek™ part number 20799, or equivalent

Injection port septa: HP™, 11 mm Thermo Red, or equivalent

Data System: Hewlett-Packard Chem server™, Target 3.5 processing software and Hewlett-Packard ChemStation software for instrument control and acquisition.

6.2 Miscellaneous Equipment

Balance: Capable of weighing to 0.1 mg

Syringes: Micro syringes; 10 uL, 25 uL, 50 uL, 100uL, 1000uL.

Vials: 2mL Autosampler vials with 200uL inserts, PFTE crimp top. 4mL sample vials with PFTE lined screw top caps.

7.0 REAGENTS AND STANDARDS

The receipt and preparation of all reagents and standard reference materials must be documented in accordance with laboratory SOPs LP-LB-0001, *Bulk Chemical and Standard Receipt, Tracking and Labeling* and LP-LB-0002, *Standard Preparation, Labeling and Storage.*

7.1 Reagents

Pesticides grade Methylene Chloride (CH_2Cl_2), Hexane, Acetone, and Methanol.

7.2 Standards

Stock standard solutions are purchased from commercial vendors and stored according to manufacturer instructions. The standards remain unopened until time of use and are considered acceptable until the expiration date given by the manufacturer. Intermediate and working standards are prepared in the laboratory by dissolving a volume of stock standard solution in an appropriate solvent and diluting to a specified volume. Standard solutions are stored in amber glass vials with Teflon lined screw caps at a temperature of $4^{o}C$ ($\pm$ 2).

The components and recommended concentration for standards used in this procedure are given below:

Primary Dilution Standard: The primary dilution standard is a combination of stock standard solutions that comprise a calibration mix (CAL MIX) at a concentration of 166.67 ng/uL in methylene chloride. The calibration mix includes all target compounds and the surrogate compounds.

Calibration or working standards are prepared by diluting the CAL MIX, in methylene chloride, into the final working concentrations that constitute the calibration range of the method (20, 50, 80, 120, 160 ng/ per 2uL injection).

Internal standard solution contains the compounds that will be used as internal standards used for final compound concentration calculation. The solution is prepared by diluting a commercially prepared mix (i.e. Restek™ Internal Standard Mix) in methylene chloride, to a concentration of 500ng/uL. Each 100uL aliquot of sample, standard, and blank is spiked with 4 uL for a final extract concentration of 20 ng/uL (40 ng on column, 2 uL injection).

Initial Calibration Verification (ICV). The ICV mix is an independent source calibration mix (separate vendor or separate lot) used to confirm the accuracy and precision of the initial calibration. The solution is prepared from ampulized stock materials that are combined to include all target compounds and surrogates. The ICV stock is diluted with methylene chloride to a final concentration of 25 ng/uL. This represents a mid point of the calibrated range and is prepared by adding 4uL of the ISTD mix to 100uL of the 25ng/uL ICV solution (50ng on column per 2uL injection).

Tune verification, or DFTPP mix (25ng/uL) is prepared from a stock standard solution that contains DFTPP, Benzidine, Pentachlorophenol, and DDT. A 2uL aliquot of this mixture is analyzed at the onset of every analytical sequence to verify compliance with mass spectral acceptance criteria and chromatographic tailing performance.

Surrogate, Matrix, and LCS spiking solutions. These solutions are spiked into samples prior to extraction and concentration. Refer to the appropriated Extraction Procedure SOP for guidelines in the preparation and use of these solutions.

8.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

8.1 Water samples should be collected in 1L amber glass containers, fitted with screw caps lined with Teflon. If amber containers are not available, the samples should be protected from light. Soil samples should be collected in glass containers or closed end tubes (e.g., brass sleeves) in sufficient quantity to perform the analysis. Air samples should be collected on PUF or XAD resin and transported with aluminum covers. Immediately following collection, all samples should be iced or refrigerated at 4°C (±2°C) and maintained at that temperature until time of extraction/analysis.

8.2 The analytical holding time for all extracts is 40 days from date of extraction. The extraction holding time for aqueous and air samples is 7 days from date of collection and 14 days from date of collection for soil/sediment samples.

8.3 Samples are stored from the time of receipt in the laboratory until 30 days after delivery of the reconciled data package report. Unless otherwise specified by a federal, state or client-specific protocol, samples are disposed of after 30 days in a manner that complies with all applicable regulations.

9.0 QUALITY CONTROL

9.1 Method Blank
A method blank is prepared with each extraction batch and analyzed on the same instrument as associated samples. The concentration of target compounds in the method

blank should not exceed the reporting limit of the method (with the exception of the phthalate compounds which may be present at 5X their reporting limit).

9.2 Laboratory Control Sample (LCS)
A laboratory control sample is analyzed with each analytical sequence. The recovery of the LCS should be within the acceptance limits given in Table 5.

9.3 Surrogate Recovery
Surrogate solution is added to all samples and the method blank prior to extraction. The percent recovery of the surrogate compounds should be within the limits given in Table 4. Unless otherwise specified by client or regulatory program, provision is made for failing recovery for one acid surrogate compound and one base neutral compound, as long as the recovery exceeds 10%. Samples that fail to meet the recovery criteria should be reanalyzed and if necessary, re-extracted.

9.4 Internal Standards
Internal standards are added to every standard, blank, matrix spike, matrix spike duplicate, and sample extract at a known concentration prior to analysis. Internal standards are used as the basis for quantitation of target compounds and their response, based on the area of the quantitation ion, must be tracked. Limits for internal standard response may not exceed –50% to +100% of those in the most recent calibration standard. Internal standard area response failures in blanks require reanalysis. Internal standard area response failures in samples may require re-analysis in the absence of interfering matrix affects.

9.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)
A MS/MSD should be performed for every 20 samples of a similar matrix per client request. The percent recovery and the relative percent difference should be within the limits given in Table 5.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Tune Standard / DFTPP

Prior to the analysis of any calibration curve, calibration verification, samples, or blanks, a tune standard is analyzed to verify that instrumentation meets the tuning acceptance criteria. A 2uL aliquot of the Tune Verification Mix is analyzed and evaluation of the DFTPP spectra is carried out by the data system and includes the summation of three scans (apex scan, scan prior, and scan preceding) with background subtraction of a scan prior to the peak.

The acceptance criteria for the DFTPP are given in Table 2. If the acceptance criteria are met then instrument calibration or calibration verification may proceed. If the acceptance

criteria are not met, the tune solution should be re-analyzed and additional corrective action performed as necessary. All subsequent standards, samples, blanks, and QC samples associated with a passing DFTPP must be acquired using identical instrument and tune conditions. Column performance and injection port inertness probes should be evaluated for tailing (pentachlorophenol and benzidine).

10.2 Initial Calibration

Prior to the analysis of samples, the instrument is calibrated with five concentration levels that define the linear range of the analysis (20, 50, 80, 120, 160 ng/ 2uL injection). Initial calibration is performed whenever calibration verification fails or instrumental conditions have been significantly modified through maintenance or repair. The initial calibration includes all compounds of interest, as specified by the project objectives and/or the methodology, at each of the concentration levels.

The analysis of the calibration standards must fall within the 12 hour analytical window as initiated by the injection time of the DFTPP standard. The concentrations of organic compounds is determined by the data system using an internal standard and fixed response model. The data system calculates a relative response factor and relative standard deviation for each compound with the following equation(s):

$$RRF = \frac{Ax * Cis}{Ais * Cx}$$

Where:
Ax = Area of characteristic ion for the compound to be measured
Ais = Area of the characteristic ion for the associated internal standard
Cis = Concentration of the internal standard (ng/uL)
Cx = Concentration of the compound to be measured (ng/uL)

$$\% \ RSD = \frac{SD}{x} * 100$$

Where:
SD = Standard deviation of initial relative response factors (per compound)
x = Mean of initial relative response factors (per compound)

The system performance check compounds (SPCC) must meet the minimum response factor shown in Table 3 and the %RSD for all target compounds must be ≤ 15%. The calibration check compounds (CCC) must have an RSD ≤ 30%. Alternatively, if the average of all RSD values for all analytes is ≤ 15% (with the exception of the CCC compounds) the calibration may still be acceptable. If criteria are not met, the problem

should be investigated and corrective action, such as instrument maintenance, cleaning, and column replacement should be performed.

10.3 Initial Calibration Verification (ICV)

Immediately following initial calibration, a second source ICV standard is analyzed to confirm the accuracy of the initial calibration. The acceptance criteria for the ICV are the same as for the CCV. If criteria are not met, the formulation of both the ICV standard and calibration standards should be evaluated and the instrument recalibrated. If time remains in the 12 hour analytical sequence after successful analysis of the ICV, samples may be analyzed. Otherwise a CCV must be performed.

10.4 Continuing Calibration Verification (CCV)

A CCV standard is analyzed every 12 hour analytical shift after the DFTPP tune standard. The standard is prepared from the calibration mix (CAL MIX) at a concentration of 25 ng/uL (50ng on column/2 uL injection). A 2uL aliquot is analyzed and the data system calculates a response factor for each compound using the same equation as in 10.2 and calculates the percent difference using the following equation:

$$\% \ Difference = \frac{RRF_i - RRF_c}{RRF_i} * 100$$

Where:
RRF_i = average relative response factor from initial calibration
RRF_c = relative response factor from current calibration check std.

The CCC and SPCC compounds must not exceed the acceptance criteria of 20%RSD and 0.050 minimum RF respectively. If the CCV fails to meet these criteria the system is considered out of control and corrective action must be taken. All other target compounds must also meet the 20%RSD criteria. If criteria are not met, the problem should be investigated and corrective action, such as instrument maintenance, cleaning, and column replacement should be performed.

Note: Target software methods list CCV criteria for non-CCC target compounds at 25%D. This is to differentiate between the CCC 20%D criterion and the criterion for evaluating other target compounds with linearity options from Method 8000 (in general non-CCC targets will be assessed using the mean %D).

11.0 PROCEDURE

11.1 Extract Preparation

Transfer a 100uL aliquot of sample extract to a labeled 1mL autosampler vial that contains an insert. Add 4uL of the internal standard spiking solution to the vial and seal with a PTFE lined crimp top cap. An alternative extract volume may be used (e.g. 50uL extract) so long as the volume of internal standard is adjusted proportionately.

Prepare sample dilutions based on screen data or historical data by diluting an appropriate volume of sample extract with Methylene Chloride. Serial dilutions may be required if relative volumes needed for a single dilution step exceed the accuracy of the pipettes (for example: a sample requires a 0.1% analysis in order to have target constituents within the upper half of the calibrated range. Preparation of a 100uL aliquot in an autosampler vial would require 0.1uL of sample extract. Microliter pipettes are graduated to 0.2uL. Therefore it would become necessary to perform a serial dilution of 1:100 (1.0%) and a 10:100 (10%) for a final extract concentration of 0.1%).

11.2 Instrument Set-Up & Analysis

Typical operating parameters can be found below. Sample acquisitions are collected, processed, and stored by the data processing system, which also generates final results and print reports.

Initial Column Conditions: 35°C for 2 minutes.
Column Temperature: 35°C to 320°C at 14°/min.
Final Temperature: 320°C for 5.6 min, or until Benzo (g,h,i) perylene has eluted
Injector Temperature: 250°C
Transfer Line Temperature: 300°C
Injector: Grob-like, splitless
Sample volume: 2μL
Carrier Gas: Helium

MS Conditions:
Electron Energy: 70 volts
Mass Range: 35-500 amu
Scantime: Not to exceed 1 second per scan

Load the vials in the autosampler tray, initiate the analytical sequence, and acquire the data.

11.3 Qualitative Identification of Target Compounds

Analytes are identified by comparison of their mass spectrum (after background subtraction) to a reference spectrum generated by a user-created database. The GC retention time for each analyte should agree within ±0.5 minutes of the retention time

found in the midpoint calibration standard for that analyte.

In general, all ions that are present above 10% relative abundance in the mass spectrum of the standard should be present in the mass spectrum of the sample component and should agree to within 20%. For example, if an ion has a relative abundance of 30% in the standard spectrum, its abundance in the sample spectrum should be in the range of 10-50%. Some ions, particularly the molecular ion, are of special importance, and should be evaluated even if they are below 10% relative abundance.

Identification of target compounds by mass spectral means requires expert judgement when components are not resolved from interfering peaks or background (non-target constituents). When chromatographic peaks or EICPs indicate contribution from interfering analytes it may become necessary to examine spectra over the entire peak and use selective background subtraction in order to positively identify target analytes and account for extraneous ions.

Identification of some isomers, due to the similarity of their spectra, is only possible when they have sufficiently different retention times. Acceptable resolution is achieved if the height of the valley between the two peaks is less than 25% of the average height of the two peaks. Otherwise, structural isomers are identified as isomeric pairs

11.4 Quantitative Identification of Target Compounds

Target compounds are quantitated by data system using the internal standard method and equations given in Section 12.0. Each compound has designated internal standard and characteristic ions. Calculation of a sample concentration using a secondary ions is done by calculating a new relative response factor, RRF^1, for the secondary ion from the check standard (substitute area of secondary ion where area of primary ion is in the equation for RRF). Secondary ion calculation is used when the primary ion shows matrix interferences in its spectra. In instances where secondary ion calculations are necessary, the narrative will state which samples were affected by interferences and required secondary ion calculations, and show the calculated results. The forms and documentation for the affected samples reflect primary ion calculations.

If the on-column concentration of any compound in any sample exceeds the initial calibration range, that sample extract must be diluted, the internal standard concentration must be readjusted, and the sample extract must be reanalyzed.

11.5 Concentrations of Unknowns

Chromatographic peaks identified by the automated search routines as non-target compounds are evaluated as tentatively identified compounds. These shall not include: 1) Peaks < 10% of the nearest internal standard; 2) peaks eluting earlier than 30 seconds

before the first target analyte; 3) VOA or SVOA target analytes or standards. Up to 20 of the highest tentatively identified compounds (TIC's) are reported. These peaks are quantitated using total peak area and an assumed response factor of 1.0.

12.0 CALCULATIONS

Unless otherwise specified, calculations are performed using ThruPut Systems© TARGET data analysis software. Secondary ion calculation is used when the primary ion shows matrix interferences in its spectra. The data system performs the calculation by calculating a new relative response factor for the secondary ion from the check standard. When secondary ion calculation is necessary, the narrative should state which samples were affected by interferences and required secondary ion calculations, and show the calculated results.

12.1 Equation 1: Target Concentration/ Water

$$C_{(x)} = \frac{A_{(x)} * Amt_{(IS)} * V_{(t)}}{A_{(IS)} * RRF * V_{(o)} * V_{(i)}} * DF$$

Where:
$C_{(x)}$ = Concentration of compound (ug/L)
$Amt_{(IS)}$ = Amount of associated internal standard (ng)
DF = Dilution Factor.
$A_{(IS)}$ = Area of quantitation ion for associated internal standard.
$A_{(x)}$ = Area of quantitation ion for compound.
RRF = Relative Response Factor from calibration standard.
$V_{(t)}$ = Volume of final extract (uL)
$V_{(o)}$ = Sample volume (mL)
$V_{(I)}$ = Volume injected (uL)

12.2 Equation 2: Target Concentration, Soil/Sediment

$$C_{(x)} = \frac{A_{(x)} * Amt_{(IS)} * V_{(t)} * GPC * 10^3 g/Kg}{A_{(IS)} * RRF * W_{(s)} * \frac{100 - M}{100} * V_{(i)} * 10^3 ng/ug} * DF$$

Where:
$C_{(x)}$ = Concentration of compound (ug/Kg)
$Amt_{(IS)}$ = Amount of associated internal standard (ng)
DF = Dilution Factor.
$A_{(IS)}$ = Area of quantitation ion for associated internal standard.
$A_{(x)}$ = Area of quantitation ion for compound.
RRF = Relative Response Factor from calibration standard.

$V_{(t)}$ = Volume of final extract (uL)
$V_{(I)}$ = Volume injected (uL)
$W_{(s)}$= Weight of sample (g)

12.3 Equation 3: Concentration of TIC's and Alkanes / Water

$$C_{(x)} = \frac{Amt_{(IS)} * H_{(x)} * V_{(t)}}{H_{(IS)} * V_{(o)} * V_{(i)}} * DF$$

Where:
$C_{(x)}$= Concentration of Unknown (ug/L).
$Amt_{(IS)}$= Amount of internal standard (ng).
DF = Dilution Factor
$H_{(x)}$ = Peak area of Unknown
$H_{(IS)}$= Peak height area of associated internal standard
$V_{(t)}$ = Volume of final extract (uL)

12.4 Equation 4: Concentration of TIC's and Alkanes / Soil

$$C_{(x)} = \frac{Amt_{(IS)} * H_{(x)} * V_{(t)} * GPC * DF * 10^3 g/Kg}{H_{(IS)} * W_{(s)} * \frac{100 - M}{100} * V_{(i)} * 10^3 ng/ug}$$

Where:
$C_{(x)}$ = Concentration of compound (ug/Kg)
$Amt_{(IS)}$ = Amount of associated internal standard (ng)
DF = Dilution Factor.
$H_{(IS)}$ = Peak area of associated internal standard.
$H_{(x)}$ = Peak area of Unknown.
$V_{(t)}$ = Volume of final extract (uL)
$V_{(I)}$ = Volume injected (uL)
$W_{(s)}$= Weight of sample (g)
GPC= GPC dilution factor (usually=2)
M= % Moisture

12.5 Equation 5: Target Concentration, Air

$$C_{(x)} = \frac{A_{(x)} * Amt_{(IS)} * V_{(t)}}{A_{(IS)} * RRF * W_{(s)} * V_{(i)} * 10^3 ng/ug} * DF$$

Where:
$C_{(x)}$ = Concentration of compound (ug/PUF)
$Amt_{(IS)}$ = Amount of associated internal standard (ng)
DF = Dilution Factor

$A_{(IS)}$ = Area of quantitation ion for associated internal standard
$A_{(x)}$ = Area of quantitation ion for compound
RRF = Mean Relative Response Factor from initial calibration standard
$V_{(t)}$ = Volume of final extract (uL)
$V_{(I)}$ = Volume injected (uL)
$W_{(s)}$= PUF=1 (unitless)

13.0 DATA ASSESSMENT, CRITERIA AND CORRECTIVE ACTION

13.1 All samples, standards and QC samples are reviewed against the performance criteria given in Section 9.0 for quality control and Section 10.0 for calibration and standardization. If the results do not fall within the established limits or criteria, corrective action should be performed. If corrective action is not taken or unsuccessful, the situation must be documented and reported in the project narrative. Primary review of the data is performed by the analyst(s) that performed the procedure. Secondary review is performed by a senior analyst or a data review analyst. All data that does not meet established criteria must be flagged with the appropriate data qualifier and noted in the project narrative.

14.0 METHOD PERFORMANCE

14.1 An Initial Demonstration of Capability is required for each analyst before unsupervised performance of this method.

14.2 MDL studies are performed following the procedure described in the reference method, 40CFR, Part 136, Appendix B and laboratory SOP LP-LB-009. The MDL is verified or repeated when a significant change to the method occurs. Significant changes include the use of alternate reagents or standard reference materials, new instrumentation or the use of alternate sample preparation procedures.

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 The laboratory optimizes technology to minimize pollution and reduce the production of hazardous waste whenever possible.

15.2 The laboratory procedures for waste management comply with applicable federal, state and local regulations and are described in SOP LP-LB-001HAZWD.

16.0 REFERENCES

16.1 Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994, Final Update IIB, January 1995, Final Update III, December 1996.

16.2 Compendium Method TO13A Determination of Polycylic Aromatic Hydrocarbons in Ambient Air using GC/MS 2nd Edition, January 1999. USEPA Office of Research and Development.

17.0 TABLES, DIAGRAMS, FLOWCHARTS AND VALIDATION FORMS

17.1 Table 1 *Target Analyte List and Reporting Limits*
17.2 Table 2 *DFTPP Criteria*
17.3 Table 3 *Initial, Continuing and Minimum Response Factor Criteria*
17.4 Table 4 *Surrogate Recovery Criteria*
17.5 Table 5 *LCS/LCSD/MS Recovery Criteria*
17.6 Table 6 *Characteristic Ions for Semivolatile Compounds and Surrogates*
17.7 Table 7 *Characteristic Ions for Internal Standards*
17.8 Table 8A/8B *Internal Standards Assigned for Quantiation*
17.8 Table 9 *QC Summary and Recommended Corrective Action*
17.9 Appendix A: *List of Definitions*

Table 1: Target Analyte List and Reporting Limits

Analyte	CAS No.	Reporting Limits			
		Water (ug/L)	Low Level Soil (ug/Kg)	Med. Level Soil ug/Kg	Air (ug)
Acenaphthene	83-32-9	10	330	10000	10
Acenaphthylene	208-96-8	10	330	10000	10
Anthracene	120-12-7	10	330	10000	10
Benzo(a)anthracene	56-55-3	10	330	10000	10
Benzo(b)fluoranthene	205-99-2	10	330	10000	10
Benzo(k)fluoranthene	207-08-9	10	330	10000	10
Benzo(g,h,i)perylene	191-24-2	10	330	10000	10
Benzo(a)pyrene	50-32-8	10	330	10000	10
4-Bromophenyl-phenylether	101-55-3	10	330	10000	NA
Butylbenzylphthalate	85-68-7	10	330	10000	NA
Carbazole	86-74-8	10	330	10000	NA
4-Chloroaniline	106-47-8	10	330	10000	NA
bis(2-Chloroethoxy)methane	111-91-1	10	330	10000	NA
bis(2-Chloroethyl)ether	111-44-4	10	330	10000	NA
4-Chloro-3-methylphenol	59-50-7	10	330	10000	NA
2-Chloronaphthalene	91-58-7	10	330	10000	NA
2-Chlorophenol	95-57-8	10	330	10000	NA
4-Chlorophenyl-phenylether	7005-72-3	10	330	10000	NA
2,2'-oxybis(1-Chloropropane)	108-60-1	10	330	10000	NA
Chrysene	218-01-9	10	330	10000	10
Dibenzofuran	132-64-9	10	330	10000	NA
Dibenz(a,h)anthracene	53-70-3	10	330	10000	10
Di-n-butylphthalate	84-74-2	10	330	10000	NA
					NA

Analyte	CAS No.	Reporting Limits			
		Water (ug/L)	Low Level Soil (ug/Kg)	Med. Level Soil ug/Kg	Air (ug)
1,3-Dichlorobenzene	541-73-1	10	330	10000	
1,4-Dichlorobenzene	106-46-7	10	330	10000	NA
3,3'-Dichlorobenzidine	91-94-1	10	330	10000	NA
2,4-Dichlorophenol	120-83-2	10	330	10000	NA
Diethylphthalate	84-66-2	10	330	10000	NA
2,4-Dimethylphenol	105-67-9	10	330	10000	NA
Dimethylphthalate	131-11-3	10	330	10000	NA
2,4-Dinitrophenol	51-28-5	25	800	25000	NA
2,4-Dinitrotoluene	121-14-2	10	330	10000	NA
2,6-Dinitrotoluene	606-20-2	10	330	10000	NA
4,6-Dinitro-2-methylphenol	534-52-1	25	800	25000	NA
Di-n-octylphthalate	117-84-0	10	330	10000	NA
bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000	NA
Fluoranthene	206-44-0	10	330	10000	10
Fluorene	86-73-7	10	330	10000	10
Hexachlorobenzene	118-74-1	10	330	10000	NA
Hexachlorobutadiene	87-68-3	10	330	10000	NA
Hexachlorocyclopentadiene	77-47-4	10	330	10000	NA
Hexachloroethane	67-72-1	10	330	10000	NA
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000	10
Isophorone	78-59-1	10	330	10000	NA
2-Methylnaphthalene	91-57-6	10	330	10000	10
2-Methylphenol	95-48-7	10	330	10000	NA
4-Methylphenol	106-44-5	10	330	10000	NA
Naphthalene	91-20-3	10	330	10000	10
2-Nitroaniline	88-74-4	25	800	25000	NA
3-Nitroaniline	99-09-2	25	800	25000	NA
4-Nitroaniline	100-01-6	25	800	25000	NA

Analyte	CAS No.	Reporting Limits			
		Water (ug/L)	Low Level Soil (ug/Kg)	Med. Level Soil ug/Kg	Air (ug)
Nitrobenzene	98-95-3	10	330	10000	NA
2-Nitrophenol	88-75-5	10	330	10000	NA
4-Nitrophenol	100-02-7	25	800	25000	NA
N-Nitrosodiphenylamine	86-30-6	10	330	10000	NA
N-Nitroso-di-n-propylamine	621-64-7	10	330	10000	NA
Pentachlorophenol	87-86-5	25	800	25000	NA
Phenanthrene	85-01-8	10	330	10000	10
Phenol	108-95-2	10	330	10000	NA
Pyrene	129-00-0	10	330	10000	NA
1,2,4-Trichlorobenzene	120-82-1	10	330	10000	NA
2,4,5-Trichlorophenol	95-95-4	25	800	25000	NA
2,4,6-Trichlorophenol	88-06-2	10	330	10000	NA

Table 2: DFTPP Criteria

Mass	Ion Abundance Criteria
51	30.0-60.0 percent of mass 198
68	less than 2.0 percent of mass 69
69	Present
70	less than 2.0 percent of mass 69
127	40.0-60.0 percent of mass 198
197	less than 1.0 percent of mass 198
198	base peak, 100 percent relative abundance
199	5.0-9.0 percent of mass 198
275	10.0-30.0 percent of mass 198
365	Greater than 1.0 percent of mass 198
441	Present, but less than mass 443
442	>40.0 of mass 198
443	17.0-23.0 percent of mass 442

Table 3:Initial, Continuing, and Minimum Response Factor Criteria

Analyte	Minimum RF	Maximum %RSD	Maximum %D
Pyridine	0.010	15	20
N-Nitrosodimethylamine	0.010	15	20
2-Fluorophenol (surr)	0.600	15	20
Phenol-d5 (surr)	0.800	15	20
Aniline	0.010	15	20
Phenol (CCC)	0.800	30	20
bis(2-Chloroethyl)Ether	0.700	15	20
2-Chlorophenol-d4 (surr)	0.800	15	20
2-Chlorophenol	0.800	15	20
1,3-Dichlorobenzene	0.600	15	20
1,4-Dichlorobenzene (CCC)	0.500	30	20
1,2-Dichlorobenzene-d4 (surr)	0.400	15	20
Benzyl Alcohol	0.010	15	20
1,2-Dichlorobenzene	0.400	15	20
2-Methylphenol	0.700	15	20
2,2'-oxybis(1-Chloropropane	0.010	15	20
4-Methylphenol	0.600	15	20
N-Nitroso-di-n-propylamine (SPCC)	0.050	15	20
Hexachloroethane	0.300	15	20
Nitrobenzene-d5 (surr)	0.200	15	20
Nitrobenzene	0.200	15	20
Isophorone	0.400	15	20
2-Nitrophenol (CCC)	0.100	30	20
2,4-Dimethylphenol	0.200	15	20
bis(2-Chloroethoxy)methane	0.300	15	20
Benzoic Acid	0.010	15	20
2,4-Dichlorophenol (CCC)	0.200	30	20
1,2,4-Trichlorobenzene	0.200	15	20
Naphthalene	0.700	15	20
4-Chloroaniline	0.010	15	20
Hexachlorobutadiene (CCC)	0.010	30	20
4-Chloro-3-methylphenol	0.010	15	20
2-Methylnaphthalene	0.010	15	20
Hexachlorocyclopentadiene (SPCC)	0.050	15	20
2,4,6-Trichlorophenol (CCC)	0.200	30	20
2,4,5-Trichlorophenol	0.200	15	20
2-Fluorobiphenyl (surr)	0.700	15	20
2-Chloronaphthalene	0.800	15	20
2-Nitroaniline	0.010	15	20
Dimethylphthalate	0.010	15	20

Analyte	Minimum RF	Maximum %RSD	Maximum %D
Acenaphthylene	0.900	15	20
2,6-Dinitrotoluene	0.200	15	20
3-Nitroaniline	0.010	15	20
Acenaphthene	0.900	15	20
2,4-Dinitrophenol (SPCC)	0.050	15	20
Dibenzofuran	0.800	15	20
4-Nitrophenol (SPCC)	0.010	15	20
2,4-Dinitrotoluene	0.200	15	20
Diethylphthalate	0.010	15	20
Fluorene	0.900	15	20
4-Chlorophenyl-phenylether	0.400	15	20
4-Nitroaniline	0.010	15	20
4,6-Dinitro-2-methylphenol	0.010	15	20
N-nitrosodiphenylamine (CCC)	0.010	30	20
Azobenzene	0.010	15	20
2,4,6-Tribromophenol (surr)	0.010	15	20
4-Bromophenyl-phenylether	0.100	15	20
Hexachlorobenzene	0.100	15	20
Pentachlorophenol (CCC)	0.050	30	20
Phenanthrene	0.700	15	20
Anthracene	0.700	15	20
Carbazole	0.010	15	20
Di-n-butylphthalate	0.010	15	20
Fluoranthene (CCC)	0.600	30	20
Benzidine	0.010	15	20
Pyrene	0.600	15	20
Terphenyl-d14 (surr)	0.500	15	20
Butylbenzylphthalate	0.010	15	20
Benzo(a)anthracene	0.800	15	20
3,3'-Dichlorobenzidine	0.010	15	20
Chrysene	0.700	15	20
bis(2-Ethylhexyl)phthalate	0.010	15	20
Di-n-octylphthalate (CCC)	0.010	30	20
Benzo(b)fluoranthene	0.700	15	20
Benzo(k)fluoranthene	0.700	15	20
Benzo(a)pyrene	0.700	15	20
Indeno(1,2,3-cd)pyrene	0.500	15	20
Dibenz(a,h)anthracene	0.400	15	20
Benzo(g,h,i)perylene	0.500	15	20

Table 4: Surrogate Recovery Limits

Surrogate Compound	Water/Air (%R)	Soil (%R)
2-Fluorophenol	21-110	25-121
Phenol-d5	10-110	24-113
2,4,6-Tribromophenol	10-123	19-122
Nitrobenzene-d5	35-114	23-120
2-Fluorobiphenyl	43-116	30-115
Terphenyl-d14	33-141	18-137
2-Chlorophenol-d4	33-110	20-130
1,2-Dichlorobenzene-d4	16-110	20-130

Note: The limits for 2-Chlorophenol-d4 and 1,2-Dichlorobenzene-d4 are advisory.

Table 5: Matrix Spike, LCS/LCSD Accuracy and Precision Limits

Compound	Water/Air	Water/Air	Soil	Soil
	%R	%RPD	%R	%RPD
Pyridine	10-62	40	15-102	40
N-Nitrosodimethylamine	10-98	40	51-119	40
Aniline	10-73	40	10-73	40
Phenol	10-80	40	59-117	40
bis(2-Chloroethyl)Ether	24-113	40	57-116	40
2-Chlorophenol	47-99	40	61-102	40
1,3-Dichlorobenzene	32-98	40	60-103	40
1,4-Dichlorobenzene	26-95	40	65-99	40
Benzyl Alcohol	27-110	40	68-117	40
1,2-Dichlorobenzene	26-99	40	65-101	40
2-Methylphenol	29-99	40	66-98	40
2,2'-oxybis(1-Chloropropane)	27-106	40	64-111	40
4-Methylphenol	34-93	40	56-112	40
Hexachloroethane	28-100	40	52-117	40
N-Nitroso-di-n-propylamine	30-110	40	50-116	40
Nitrobenzene	23-110	40	58-111	40
Isophorone	29-108	40	52-119	40
2-Nitrophenol	18-119	40	62-115	40
2,4-Dimethylphenol	25-107	40	33-120	40
bis(2-Chloroethoxy)methane	39-103	40	39-103	40
2,4-Dichlorophenol	30-112	40	56-115	40
Benzoic Acid	10-82	40	10-146	40
1,2,4-Trichlorobenzene	33-95	40	63-111	40
Naphthalene	31-105	40	61-104	40
4-Chloroaniline	15-77	40	10-81	40
Hexachlorobutadiene	35-99	40	52-121	40
4-Chloro-3-methylphenol	39-116	40	61-116	40
2-Methylnaphthalene	42-118	40	64-110	40
Hexachlorocyclopentadiene	10-89	40	10-146	40
2,4,6-Trichlorophenol	44-110	40	10-140	40
2,4,5-Trichlorophenol	43-114	40	34-122	40
2-Chloronaphthalene	48-101	40	72-110	40
2-Nitroaniline	47-120	40	60-126	40
Dimethylphthalate	32-104	40	62-119	40
Acenaphthylene	43-98	40	59-104	40
2,6-Dinitrotoluene	44-113	40	71-108	40
3-Nitroaniline	26-93	40	44-79	40

Acenaphthene	47-99	40	59-111	40
2,4-Dinitrophenol	10-112	40	10-208	40
Dibenzofuran	49-109	40	67-121	40
4-Nitrophenol	10-94	40	42-147	40
2,4-Dinitrotoluene	47-114	40	60-121	40
Diethylphthalate	48-108	40	62-118	40
Fluorene	49-109	40	61-120	40
4-Chlorophenyl-phenylether	47-108	40	67-110	40
4-Nitroaniline	55-108	40	44-105	40
4,6-Dinitro-2-methylphenol	17-135	40	30-166	40
N-nitrosodiphenylamine	39-103	40	57-116	40
Azobenzene	49-119	40	66-132	40
4-Bromophenyl-phenylether	37-109	40	67-101	40
Hexachlorobenzene	27-126	40	52-122	40
Pentachlorophenol	17-114	40	19-94	40
Phenanthrene	51-103	40	66-111	40
Anthracene	52-104	40	59-120	40
Carbazole	66-147	40	56-145	40
Di-n-butylphthalate	55-104	40	62-118	40
Fluoranthene	52-116	40	49-131	40
Benzidine	10-99	40	10-120	40
Pyrene	41-119	40	46-124	40
Butylbenzylphthalate	51-117	40	56-129	40
Benzo(a)anthracene	52-107	40	62-116	40
3,3'-Dichlorobenzidine	14-105	40	29-99	40
Chrysene	47-112	40	49-121	40
bis(2-Ethylhexyl)phthalate	46-106	40	46-106	40
Di-n-octylphthalate	61-108	40	65-120	40
Benzo(b)fluoranthene	25-121	40	44-119	40
Benzo(k)fluoranthene	35-141	40	57-128	40
Benzo(a)pyrene	43-106	40	60-109	40
Indeno(1,2,3-cd)pyrene	20-127	40	10-149	40
Dibenz(a,h)anthracene	22-126	40	21-142	40
Benzo(g,h,i)perylene	28-100	40	10-167	40

Table 6: Characteristic Ions for Semivolatile Target Compounds and Surrogates

Parameter	Primary Quantitation Ion	Secondary Ion (s)
Phenol	94	65, 66
bis(2-Chloroethyl)ether	93	63, 95
2-Chlorophenol	128	64, 130
1,3-Dichlorobenzene	146	148, 113
1,4-Dichlorobenzene	146	148, 113
1,2-Dichlorobenzene	146	148, 113
2-Methylphenol	108	107
2,2'-oxybis(l-Chloropropane)	45	77, 79
4-Methylphenol	108	107
N-Nitroso-di-n-propylamine	70	42, 101, 130
Hexachloroethane	117	201, 199
Nitrobenzene	77	123, 65
Isophorone	82	95, 138
2-Nitrophenol	139	65, 109
2,4-Dimethylphenol	107	121, 122
bis(2-Chloroethoxy)methane	93	95, 123
2,4-Dichlorophenol	162	164, 98
1,2,4-Trichlorobenzene	180	182, 145
Naphthalene	128	129, 127
4-Chloroaniline	127	129
Hexachlorobutadiene	225	223, 227
4-Chloro-3-methylphenol	107	144, 142
2-Methylnaphthalene	142	141
Hexachlorocyclopentadiene	237	235, 272
2,4,6-Trichlorophenol	196	198, 200
2,4,5-Trichlorophenol	196	198, 200

Parameter	Primary Quantitation Ion	Secondary Ion (s)
2-Chloronaphthalene	162	164, 127
2-Nitroaniline	65	92, 138
Dimethyl phthalate	163	194, 164
Acenaphthylene	152	151, 153
3-Nitroaniline	138	108, 92
Acenaphthene	153	152, 154
2,4-Dinitrophenol	184	63, 154
4-Nitrophenol	109	139, 65
Dibenzofuran	168	139
2,4-Dinitrotoluene	165	63, 182
2,6-Dinitrotoluene	165	89, 121
Diethylphthalate	149	177, 150
4-Chlorophenyl-phenylether	204	206, 141
Fluorene	166	165, 167
4-Nitroaniline	138	92, 108
4,6-Dinitro-2-methylphenol	198	182, 77
N-Nitrosodiphenylamine	169	168, 167
4-Bromophenyl-phenylether	248	250, 141
Hexachlorobenzene	284	142, 249
Pentachlorophenol	266	264, 268
Phenanthrene	178	179, 176
Anthracene	178	179, 176
Carbazole	167	166, 139
Di-n-butylphthalate	149	150, 104
Fluoranthene	202	101, 100
Pyrene	202	101, 100
Butylbenzylphthalate	149	91, 206

Parameter	Primary Quantitation Ion	Secondary Ion (s)
3,3'-Dichlorobenzidine	252	254, 126
Benzo(a)anthracene	228	229, 226
bis(2-Ethylhexyl)phthalate	149	167, 279
Chrysene	228	226, 229
Di-n-Octyl phthalate	149	--
Benzo(b)fluoranthene	252	253, 125
Benzo(k)fluoranthene	252	253, 125
Benzo(a)pyrene	252	253, 125
Indeno(1,2,3-cd)pyrene	276	138, 227
Dibenzo(a,h)anthracene	278	139, 279
Benzo(g,h,i)perylene	276	138, 277
Phenol-d(5)	99	42, 71
2-Fluorophenol	112	64
2,4,6-Tribromophenol	330	332, 141
Nitrobenzene-d(5)	82	128, 54
2-Fluorobiphenyl	172	171
Terphenyl-d(14)	244	122, 212
2-Chlorophenol-d(4)	132	68, 134
1,2-Dichlorobenzene-d(4)	152	115, 150

Table 7:Characteristic Ions for Internal Standards

Internal Standard	Primary Quantitation Ion	Secondary Ions
1,4-Dichlorobenzene-d(4)	152	115
Naphthalene-d(8)	136	68
Acenaphthene-d(10)	164	162,160
Phenanthrene-d(10)	188	94,80
Chrysene-d(12)	240	120,236
Perylene-d(12)	264	260,265

Table 8A: Internal Standards Assigned for Quantitation

1,4-Dichlorobenzene-d(4)	Naphthalene-d(8)	Acenaphthene-d(10)
Phenol	Nitrobenzene	Hexachlorocyclopentadiene
bis (2-Chloroethyl) ether	Isophorone	2,4,6-Trichlorophenol
2-Chlorophenol	2-Nitrophenol	2,4,5-Trichlorophenol
1,3-Dichlorobenzene	2,4-Dimethylphenol	2-Chloronaphthalene
1,4-Dichlorobenzene	bis(2-Chloroethoxy)methane	2-Nitroaniline
1,2-Dichlorobenzene	2,4-Dichlorophenol	Dimethylphthalate
2-Methylphenol	1,2,4-Trichlorobenzene	Acenaphthylene
2,2'-oxybis-(1Chloropropane)	Naphthalene	3-Nitroaniline
4-Methylphenol	4-Chloroanaline	Acenaphthene
N-Nitroso-Di-n-propylamine	Hexachlorobutadiene	2,4-Dinitrophenol
Hexachloroethane	4-Chloro-3-methylphenol	4-Nitrophenol
2-Fluorophenol (surr)	2-Methylnapthalene	Dibenzofuran
Phenol-d(5)(surr)	Nitrobenzene-d(5) (surr)	2,4-Dinitrotoluene
2-Chlorophenol-d(4) (surr)		2,6-Dinitrotoluene
1,2-Dichlorobenzene-d(4) (surr)		Diethylphthalate
		4-Chlorophenylphenylether
		Fluorene

1,4-Dichlorobenzene-d(4)	Naphthalene-d(8)	Acenaphthene-d(10)
		4-Nitroaniline
		2-Fluorobiphenol (surr)

Table 8B: Internal Standards Assigned for Quantiation

Phenanthrene-d(12)	**Chrysene-d(12)**	**Perylene-d(12)**
4,6-Dinoitro-2-methylphenol	Pyrene	Di-n-octylphthalate
N-nitroso-di-phenylamine	Butylbenzyl phthalate	Benzo(b)fluoranthene
4-Bromophenyl phenolether	3,3'-Dichlorobenzidine	Benzo(k)fluor anthene
Hexachlorobenzene	Benzo(a) anthracene	Benzo(a)pyrene
Pentachlorophenol	bis(2-ethyl-hexyl)phthalate	Indeno(1,2,3-cd)-pyrene
Carbazole	Chrysene	Benzo(g,h,i)-perylene
Phenanthrene	Terphenyl-d(14)(surr)	Dibenzo(a,h)-anthracene
Anthracene		
Di-n-butylphthalate		
Fluoranthene		
2,4,6-Tribromophenyl(surr)		

Table 9: QC Summary & Recommended Corrective Action

QC Item	Frequency	Acceptance Criteria	Recommended Corrective Action
DFTPP Tune Standard	Every 12 hours	See Table 2	Reanalyze
ICAL	Initially, when CCV fails	CCC <30% RSD Non-CCC <15%RSD SPCC >0.050RRF	Reanalyze
ICV	After each ICAL	CCC<20%D Non-CCC < 15% SPCC>0.050RRF	Evaluate standard prep, reanalyze, prepare new standards, recalibrate
CCV	After each DFTPP except in analytical windows for which an ICAL was performed	CCC<20%D Non-CCC < 15% SPCC>0.050RRF	Reanalyze, recalibrate
Method Blank	One per 20 samples or each extraction batch	Targets < RL Phthlates < 5XRL	Re-extract along with associated samples
LCS	One per 20 samples or each extraction batch	%R: See Table 5	Re-extract along with associated samples
MS/MSD	One per 20 samples per client request	%R: See Table 5 %RPD: See Table 5	Reanalyze, note outages in project narrative
Surrogate	Every sample, blank, standard	%R: See Table 4	Reanalyze, Re-extract

Appendix A: List of Definitions

INTERNAL STANDARD: Non-target analyte compounds that are similar to the target analytes but are not expected to be found in environmental media (generally, isotopically labeled target analytes are used for this purpose) and are added to every standard, quality control sample, and field sample at a known concentration prior to analysis. IS responses are used as the basis for quantitation of target analytes.

SURROGATENon-target analyte compounds that are similar in composition and behavior to the target analytes but are not expected to be found in environmental media (often, isotopically labeled target analytes are used for this purpose) and are added to every standard, quality control sample, and field sample at a known concentration prior to preparation and/or analysis. Surrogate responses are used to evaluate the accuracy of the laboratory's performance of the analytical method in a specific sample matrix.

STOCK STANDARD SOLUTION: A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

PRIMARY DILUTION STANDARD SOLUTION: A solution of several analytes prepared in the laboratory from stock standard solutions and diluted as needed to prepare calibration solutions and other needed analyte solutions.

CALIBRATION STANDARD (CAL): A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

INITIAL CALIBRATION VERIFICATION (ICV): An analytical standard solution containing all target analytes, surrogate and internal standard compounds that are prepared from a source external to the laboratory and independent from the source of the initial calibration standards. The purpose of the ICV is to verify that the initial calibration is in control.

CONTINUING CALIBRATION VERIFICATION (CCV): An analytical standard solution containing all target analytes, surrogate and internal standard compounds that is used to evaluate the performance of the instrument system with respect to a defined set of method criteria.

METHOD BLANK (SBLK, similarly known as the LABORATORY REAGENT BLANK): An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The SBLK is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

LABORATORY CONTROL SAMPLE (LCS): The LCS consists of an aliquot of a clean (control) matrix similar to the sample matrix and of the same weight or volume. Its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. When the results of the matrix spike analysis indicates a potential problem due to the sample matrix itself, the LCS results are used to verify that the laboratory can perform the analysis in a clean matrix.

LABORATORY FORTIFIED SAMPLE MATRIX/SAMPLE MATRIX DUPLICATE (MS/MSD): An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS/MSD is analyzed exactly like a sample. Its purpose is used to evaluate the accuracy and precision of the laboratory performance of the analytical method in a specific sample matrix.

SYSTEM PERFORMANCE CHECK COMPOUNDS (SPCCs): Selective analytes from the compound list that are used to check compound instability and to check for degradation caused by contaminated lines or active sites in the system. These compounds are identified in Table 3 (SPCC).

CALIBRATION CHECK COMPOUNDS (CCCs): Selective analytes from the compound list that are used to evaluate the calibration from the standpoint of the integrity of the system. High variability for these compounds may be indicative of system leaks or reactive sites on the column. These compounds are identified in Table 3 (CCC).

LABORATORY QUALITY MANUAL

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Colchester, Vermont 05446
(802) 655-1203
(802) 655-1248 FAX

Severn Trent Laboratories, Inc.

REVISION 22

LABORATORY QUALITY MANUAL
Revision 22

Approved Signatures:

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Date: February 12, 2003

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Table of Contents

Tables

Figures

Appendices

1. Introduction, Purpose, and Scope

1.1. STL Burlington Overview

STL Burlington located in Colchester, Vermont was established in 1970 in response to a need for hydrographic studies in support of the nuclear power industry and water quality testing.

The laboratory is now a part of Severn Trent Laboratories, Inc. (STL). STL is a national group of laboratories that offers a broad range of environmental testing services provided by over two thousand professionals in the US. STL Burlington's testing capabilities include chemical, physical, and biological analyses of a variety of matrices, including aqueous, solid, drinking water, waste, tissue, air toxics and saline/estuarine samples. Specialty capabilities include geotechnical testing and tissue preparation and analysis. STL facility locations and contact information is provided in Table 1.

1.2. Quality Assurance Policy

It is STL's policy to:

- Provide high quality, consistent, and objective environmental testing services that meet all federal, state, and municipal regulatory requirements.
- Generate data that are scientifically sound, legally defensible, meet project objectives, and are appropriate for their intended use.
- Provide STL clients with the highest level of professionalism and the best service practices in the industry.
- Build continuous improvement mechanisms into all laboratory, administrative, and managerial activities.
- Maintain a working environment that fosters open communication with both clients and staff.

1.3. Management Commitment to Quality Assurance

The management of STL Burlington is committed to providing the highest quality data and the best service in the environmental testing industry. To ensure that the data produced and reported by the laboratory meet the requirements of its clients and comply with the letter and spirit of municipal, state and federal regulations, STL Burlington maintains a Quality System that is clear, effective, well communicated, and supported at all levels in the company.

STL Mission Statement

Through the innovation and dedication of our people, together with the quality of our systems, we will deliver levels of performance that delight our clients, retain the confidence of our stakeholders and enable profitable growth of our business.

1.4. Purpose

The purpose of the Laboratory Quality Manual (LQM) is to describe the laboratory quality system and to outline how that system enables all employees to meet the Quality Assurance (QA) policy. The LQM also describes specific QA activities and requirements and prescribes their frequencies. Roles and responsibilities of management and laboratory staff in support of the quality system are also defined in the LQM.

1.5. Scope

The requirements set forth in this document apply to all laboratory activities. Where the document uses the terms "must" and "shall", this denotes required activities. Practices described in this LQM denote how those activities are generally performed. A more detailed description of the activity may be provided in laboratory standard operating procedures.

The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where this LQM conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. Secondarily, the laboratory shall operate in compliance with documented client requirements, where they do not conflict with regulatory requirements. STL Burlington shall not enter any client agreements that conflict with regulatory requirements in the jurisdiction in which the work is performed. Where documented client agreements conflict with this LQM but meet the regulatory requirements of the jurisdiction in which the work is performed, the client agreement shall supercede the requirements in the LQM.

STL Burlington operates under the regulations and guidelines of the following federal programs:

- Air Force Center for Environmental Excellence (AFCEE)
- US Army Corp of Engineers, Hazardous, Toxic and Radioactive Waste (USACE HTRW)
- Clean Air Act (CAA)
- Clean Water Act (CWA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Department of Energy (DOE)
- Marine Protection, Research, and Sanctuaries Act (MPRSA)
- Navy Facilities Engineering Service Center (NFESC)
- National Pollution, Discharge, and Elimination System (NPDES)
- Occupational Safety and Health Administration (OSHA)
- Resource Conservation and Recovery Act (RCRA)
- Safe Drinking Water Act (SDWA)
- Toxic Substances Control Act (TSCA)

STL Burlington also provides services under various state and local municipal guidelines. A listing of laboratory service offerings and certifications are provided in Appendix A and Appendix B,

respectively. Current information is also presented on the MySTL web page or is available on request from the laboratory.

This LQM was written to comply with the STL Corporate Quality Management Plan (QMP) and with the National Environmental Accreditation Conference (NELAC) standards.

The LQM undergoes review by the QA Manager, the General Manager, the Laboratory Director and the Technical Directors at a minimum frequency of every two years. Revisions to the LQM are distributed throughout the laboratory to replace the outdated copies so that only the most current revision is in use. It is the joint responsibility of the QA Manager, the Laboratory Director, the Technical Directors and Laboratory Section Managers to ensure that all employees are trained on and comply with, the procedures described in the LQM and associated documentation.

TABLE 1: STL FACILITY LOCATIONS

STL Austin
14046 Summit Drive
Suite 111
Austin, TX 78728
Phone: 512-244-0855
Fax: 512-244-0160

STL Billerica
149 Rangeway Road
N. Billerica, MA 01862
Phone: 978-667-1400
Fax: 978-667-7871

STL Buffalo
10 Hazelwood Drive
Suite 106
Amherst, NY 14228
Phone: 716-691-2600
Fax: 716-691-7991

STL Burlington
208 South Park Drive
Suite 1
Colchester, VT 05446
Phone: 802-655-1203
Fax: 802-655-1248

STL Connecticut
128 Long Hill Cross Road
Shelton, CT 06484
Phone: 203-929-8140
Fax: 203-929-8142

STL Chicago
2417 Bond Street
University Park, IL 60466
Phone: 708-534-5200
Fax: 708-534-5211

STL Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Phone: 361-289-2673
Fax: 361-289-2471

STL Denver
4955 Yarrow Street
Arvada, CO 80002
Phone: 303-421-6611
Fax: 303-431-7171

STL Edison
777 New Durham Road
Edison, NJ 08817
Phone: 732-549-3900
Fax: 732-549-3679

STL Houston
6310 Rothway Drive
Suite 130
Houston, TX 77040
Phone: 713-690-4444
Fax: 713-690-5646

STL Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Phone: 865-291-3000
Fax: 865-584-4315

STL Los Angeles
1721 South Grand Avenue
Santa Ana, CA 92705
Phone: 714-258-8610
Fax: 714-258-0921

STL Miami
10200 USA Today Way
Miramar, FL 33025
Phone: 954-431-4550
Fax: 954-431-1959

STL Mobile
900 Lakeside Drive
Mobile, AL 36693
Phone: 334-666-6633
Fax: 334-666-6696

STL Newburgh
315 Fullerton Avenue
Newburgh, NY 12550
Phone: 845-562-0890
Fax: 845-562-0841

STL North Canton
4101 Shuffel Drive NW
North Canton, OH 44720
Phone: 330-497-9396
Fax: 330-497-0772

STL On-Site Technology
Westfield Executive Park
53 Southampton Road
Westfield, MA 01085
Phone: 413-572-4000
Fax: 413-572-3707

STL Pensacola
3355 McLemore Drive
Pensacola, FL 32514
Phone: 850-474-1001
Fax: 850-478-2671

STL Pittsburgh
450 William Pitt Way
Building 6
Pittsburgh, PA 15238
Phone: 412-820-8380
Fax: 412-820-2080

STL Richland
2800 George Washington Way
Richland, WA 99352
Phone: 509-375-3131
Fax: 509-375-5590

STL Sacramento
880 Riverside Parkway
West Sacramento, CA 95605
Phone: 916-373-5600
Fax: 916-372-1059

STL San Fransisco
1220 Quarry Lane
Pleasanton, CA 94566-4756
Phone: 925-484-1919
Fax: 925-484-1096

STL Savannah
5102 LaRoche Avenue
Savannah, GA 31404
Phone: 912-354-7858
Fax: 912-351-3673

STL Seattle
5755 8th Street, East
Tacoma, WA 98424
Phone: 253-922-2310
Fax: 253-922-5047

STL St. Louis
13715 Rider Trail North
Earth City, MO 63045
Phone: 314-298-8566
Fax: 314-298-8757

STL Tallahassee
2846 Industrial Plaza Dr.
Tallahassee, FL 32301
Phone: 850-878-3994
Fax: 850-878-9504

STL Tampa West
6712 Benjamin Road
Suite 100
Tampa, FL 33634
Phone: 813-885-7427
Fax: 813-885-7049

STL Valparaiso
2400 Cumberland Drive
Valparaiso, IN 46383
Phone: 219-464-2389
Fax: 219-462-2953

STL Westfield
Westfield Executive Park
53 Southampton Road
Westfield, MA 01085
Phone: 413-572-4000
Fax: 413-572-3707

2. References

The following references were used in preparation of this document and as the basis of the laboratory Quality System:

EPA Guidance for the Preparation of Standard Operating Procedures (SOPs) for Quality Related Documents, EPA QA/G-6, US EPA, Office of Environmental Information, March 2001.

EPA Requirements For Quality Management Plans, EPA QA/R-2, US EPA, Office of Environmental Information, March 2001.

EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, US EPA, Office of Environmental Information, March 2001.

EPA Quality Manual for Environmental Programs, 5360 A1, US EPA, Office of Environmental Information, March 2001.

General Requirements for the Competence of Testing and Calibration Laboratories, ISO/IEC 17025, December 1999.

Good Automated Laboratory Practices, EPA 2185, 1995.

Quality Assurance Project Plan, HQ Air Force Center for Environmental Excellence, Version 3.1, August 2001.

National Environmental Laboratory Accreditation Conference, Constitution, Bylaws, and Standards, EPA600/R-98/151, USEPA Office of Research and Development, July 1999.

Navy Installation Restoration Laboratory Quality Assurance Guide, Interim Guidance Document, Naval Facilities Engineering Service Center, February 1996.

Navy Installation Restoration Chemical Data Quality Manual, Navy IR CDQM, September 1999.

Quality Systems Manual for Environmental Laboratories, Department of Defense, Version 1, October 2000.

Shell for Analytical Chemistry Requirements, US Army Corps of Engineers, December 1998.

3. Terms and Definitions

Accuracy: the degree of agreement between a measurement and true or expected value, or between the average of a number of measurements and the true or expected value.

Audit: a systematic evaluation to determine the conformance to specifications of an operational function or activity.

Batch: environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of a similar matrix, meeting the above mentioned criteria. Where no preparation method exists (example, volatile organics, water) the batch is defined as environmental samples that are analyzed together with the same process and personnel, using the same lots of reagents, not to exceed 20 environmental samples. An analytical batch is composed of prepared environmental samples, extracts, digestates or concentrates that are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

Chain of Custody (COC): an unbroken trail of accountability that ensures the physical security of samples, data and records.

Clean Air Act: legislation in 42 U.S.C. 7401 et seq., Public Law 91-604, 84 Stat. 1676 Pub. L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/Superfund): legislation (42 U.S.C. 9601-9675 et seq., as amended by the Superfund Amendments and reauthorization Act of 1986 (SARA), 42 U.S.C. 9601et seq.

Compromised Sample: a sample received in a condition that jeopardizes the integrity of the results. See Section 4.7.1 for a description of these conditions.

Confidential Business Information (CBI): information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products.

Confirmation: verification of the presence of a component using an additional analytical technique. These may include second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors, or additional cleanup procedures.

Corrective Action: action taken to eliminate the causes of an existing non-conformance, defect or other undesirable situation in order to prevent recurrence.

Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality.

Demonstration of Capability (DOC): procedure to establish the ability to generate acceptable accuracy and precision.

Equipment Blank: a portion of the final rinse water used after decontamination of field equipment; also referred to as Rinsate Blank and Equipment Rinsate.

Document Control: the act of ensuring that documents (electronic or hardcopy and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA): legislation under 7 U.S.C. 135 et seq., as amended.

Federal Water Pollution Control Act (Clean Water Act, CWA): legislation under 33 U.S.C. 1251 et seq., Public Law 92-50086 Stat. 816.

Field Blank: a blank matrix brought to the field and exposed to field environmental conditions.

Field of Testing (FOT): a field of testing is based on NELAC's categorization of accreditation.

Good Laboratory Practices (GLP): formal regulations for performing basic laboratory operations outlined in 40 CFR Part 160 and 40 CFR Part 729 and required for activities performed under FIFRA and TSCA.

Holding Time: the maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Instrument Blank: a blank matrix that is the same as the processed sample matrix (i.e. extract, digestate, condensate) and introduced onto the instrument for analysis.

Internal Chain of Custody: an unbroken trail of accountability that ensures the physical security of samples, data and records. Internal Chain of Custody refers to additional documentation procedures implemented within the laboratory that includes special sample storage requirements, and documentation of all signatures and/or initials, dates, and times of personnel handling specific samples or sample aliquots.

Instrument Detection Limit (IDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ±100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (LCS): a blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Laboratory Quality Manual (LQM): a document stating the quality policy, quality system and quality practices of the laboratory. The LQM may include by reference other documentation relating to the laboratory's quality system.

Limit of Detection (LOD): the minimum amount of a substance that an analytical process can reliably detect.

Matrix: the substrate of a test sample. Common matrix descriptions are defined in Table 2.

Table 2: Matrix Descriptions

Matrix	Description
Air	Air samples as analyzed directly or as adsorbed into a solution or absorption matrix and desorbed.
Aqueous	Aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine source. Includes surface water, groundwater and effluents.
Drinking Water	Aqueous sample that has been designated a potable water source.
Saline	Aqueous sample from an ocean or estuary, or other salt-water source such as the Great Salt Lake.
Liquid	Liquid with <15% settleable solids.
Solid	Soil, sediment, sludge or other matrices with ≥15% settleable solids.
Waste	A product or by-product of an industrial process that results in a matrix not previously defined.
Tissue	Sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Matrix Duplicate (MD): duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate; Laboratory Duplicate.

Matrix Spike (MS): field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD) : a replicate matrix spike.

Method Blank: a blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Method Detection Limit (MDL): the minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs using a specific method. Quantitative results are not produced in this range.

Non-conformance: an indication, judgement, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Precision: an estimate of variability. It is an estimate of agreement among individual measurements of the same physical or chemical property, under prescribed similar conditions.

Preservation: refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical and/or biological integrity of the sample.

Proficiency Testing: determination of the laboratory calibration or testing performance by means of inter-laboratory comparisons.

Proficiency Test (PT) Sample: a sample, the composition of which is unknown to the analyst, that is provided to test whether the analyst/laboratory can produce analytical results within specified performance limits. Also referred to as Performance Evaluation (PE) Sample.

Proprietary: belonging to a private person or company.

Quality Assurance (QA): an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality Assurance Project Plan (QAPP): a formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.

Quality Control (QC): the overall system of technical activities, the purpose of which is to measure and control the quality of a product or service.

Quality Control Sample: a control sample, generated at the laboratory or in the field, or obtained from an independent source, used to monitor a specific element in the sampling and/or testing process.

Quality Management Plan (QMP): a formal document describing the management policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an agency, organization or laboratory to ensure the quality of its product and the utility of the product to its users.

Quality System: a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA/QC.

Quantitation Limit (QL): the minimum amount of a substance that can be quantitatively measured with a specified degree of confidence and within the accuracy and precision guidelines of a specific measurement system. The QL can be based on the MDL, and is generally calculated as 3-5 times the MDL, however, there are analytical techniques and methods where this relationship is not applicable. Also referred to as Practical Quantitation Level (PQL), Estimated Quantitation Level (EQL), Limit of Quantitation (LOQ).

Raw Data: any original information from a measurement activity or study recorded in laboratory notebooks, worksheets, records, memoranda, notes, or exact copies thereof and that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic/optical media, including dictated observations, and recorded data from automated instruments. Reports specifying inclusion of "raw data" do not need all of the above included, but sufficient information to create the reported data.

Record Retention: the systematic collection, indexing and storing of documented information under secure conditions.

Reference Standard: a standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived.

Reporting Limit (RL): The level to which data is reported for a specific test method and/or sample. The RL is generally related to the QL. The RL must be minimally at or above the MDL.

Resource Conservation and Recovery Act (RCRA): legislation under 42 USC 321 et seq. (1976).

Safe Drinking Water Act (SDWA): legislation under 42 USC 300f et seq. (1974), (Public Law 93-523).

Sampling and Analysis Plan (SAP): a formal document describing the detailed sampling and analysis procedures for a specific project.

Selectivity: the capability of a measurement system to respond to a target substance or constituent.

Sensitivity: the difference in the amount or concentration of a substance that corresponds to the smallest difference in a response in a measurement system using a certain probability level.

Spike: a known amount of an analyte added to a blank, sample or sub-sample.

Standard Operating Procedure (SOP): a written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

Storage Blank: a blank matrix stored with field samples of a similar matrix.

Systems Audit: a thorough, systematic, on-site, qualitative review of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system.

Test Method: defined technical procedure for performing a test.

Toxic Substances Control Act (TSCA): legislation under 15 USC 2601 et seq., (1976).

Traceability: the property of a result of a measurement that can be related to appropriate international or national standards through an unbroken chain of comparisons.

Trip Blank: a blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Verification: confirmation by examination and provision of evidence against specified requirements.

4. Management & Quality System Requirements

4.1 Organization and Management

4.1.1 Organization

STL Burlington's organizational structure is presented in Figure 1. Corporate STL employees are located at various STL facilities as outlined in the organizational structure presented in Figure 2. The laboratory is under the supervision of a General Manager who reports to the Environmental Chief Operating Officer (COO), a Laboratory Director who reports to the General Manager, and a QA Manager who reports to the Laboratory Director and also has an indirect reporting relationship to the STL Corporate QA Director. In the case of temporary absence, the direct supervisor will assume the responsibilities of the absent employee or delegate the responsibility to qualified personnel.

4.1.2 Roles and Responsibilities

The roles and responsibilities of key personnel are described in this section. A complete list of job descriptions including essential duties and responsibilities, secondary duties, working relationships, and other requirements for all positions of the laboratory is maintained by and available upon request from the Human Resources Coordinator.

General Manager (GM)
The General Manager reports to the Chief Operating Office and is directly responsible for the daily operations of one or more operating facilities within STL. The GM's responsibilities include allocation of personnel and resources, long term planning, setting goals and achieving the financial, business and quality objectives of STL. The GM ensures timely compliance with corporate management directives, policies and management system reviews. The GM is an approved laboratory signatory.

Laboratory Director (LD)
The Laboratory Director reports to the General Manager and oversees the daily operations of the laboratory. The LD responsibilities include supervision of staff, setting goals and objectives for both the business and the employees, and achieving the financial, business, technical and quality objectives of the laboratory. The LD ensures timely compliance with audits and corrective actions, and is responsible for maintaining a working environment that encourages open, constructive problem solving for continuous improvement. The LD is an approved laboratory signatory.

QA Manager (QAM)
The QA Manager reports to the Laboratory Director and has an indirect reporting relationship to the STL Corporate QA Director. The QAM is responsible for the development and implementation of the laboratory quality system. The QAM responsibilities include ensuring that the laboratory's quality system meets the requirements set forth in the STL Corporate Quality Management Plan (QMP), providing quality systems training to all new personnel, maintaining the Laboratory Quality Manual (LQM) and standard operating procedures (SOPs), and performing or overseeing systems, data, special

and external audits. The QAM performs or supervises the maintenance of QA records, the maintenance of certifications and accreditations, the submission of monthly QA reports, and assists in reviewing new work as needed. The QAM has the final authority to accept or reject data, and to stop work in progress in the event that procedures or practices compromise the validity and integrity of analytical data. The QAM is an approved laboratory signatory.

Technical Director (TD)
The Technical Director(s) reports to the Laboratory Director and has overall responsibility for a defined portion of the laboratory. The Technical Director solves day to day technical issues, provides technical training and guidance to laboratory staff, project managers, and clients, investigates technical issues identified by QA, and directs evaluation of new methods. The Technical Director(s) is approved laboratory signatories.

Section Manager
The Section Manager(s) report to the Laboratory Director and may or not be a Technical Director(s). The Section Manager has responsibilities for a defined portion of the laboratory that include work scheduling, development, execution and supervision of analytical procedures including SOP review and revision, secondary data review, staff training, goal setting and monitoring lab activities to achieve the quality objectives set forth in the LQM and standard operating procedures. Section Coordinators are assigned by the Section Manager and have various responsibilities as assigned by the Section Manager.

Customer Service Manager (CSM)
The Customer Service Manager supervises the Project Management staff. Compiles and interprets the receipts forecast and tracks and maintains information for various revenue reports. The CSM is responsible for the evaluation and preparation of bids and proposals for new business opportunities and overseeing the project management bid activity for existing client base.

Project Manager (PM)
The Project Manager(s) report to the Laboratory Director and is responsible for direct communication with the client, coordination of laboratory services, work scheduling and dissemination of project requirements to the laboratory operation. The PM writes project narratives, performs tertiary data review, investigates and resolves technical and service related issues that arise during the course of the project.

Chemist and/or Analyst
Chemists and Analysts report to the respective Section Manager and are responsible for analysis of samples and generation of analytical data in accordance with the requirements set forth in the LQM, written standard operating procedures, and project specifications.

Sample Custodian
The Sample Custodian(s) report to the respective Section Manager and is responsible for the receipt and handling of samples within the laboratory. Responsibilities include adherence to the laboratory sample acceptance policy, initiation of internal chain of custody, when needed, sample log-in and tracking, sample security and storage, and sample disposal.

Information Technology
The IT Staff report to a Section Manager and are responsible for the design and maintenance of the laboratory's computer hardware and software. Responsibilities include preparation and maintenance of the Information Systems Quality Manual (ISQM), implementation and validation of new data systems, network administration, hardware and software maintenance, review, generation and implementation of electronic data deliverables (EDD) and the provision of technical support and training to all laboratory staff.

Human Resource Coordinator
The Human Resources Coordinator provides support to the laboratory and Corporate Human Resources by implementing and administering Human Resources programs and procedures and advises managers on Human Resources-related issues. Serves as a resource to the laboratory employees with HR-related issues and coordinates employee recognition programs and special events to foster a positive and rewarding work environment. Performs HR administrative duties in support of all laboratory departments.

Environmental Health & Safety Coordinator
The Employee Health and Safety Coordinator is responsible for administering the EH&S program that provides a safe, healthy working environment for all employees and the environment. Monitors all areas for unsafe conditions, acts, and potential hazards. Enforces environmental, health, and safety policies and procedures. Maintains regulatory compliance with local, state, and federal laws. Makes safety and health recommendations to laboratory management in conjunction with the facility safety committee. Develops the facility Integrated Contingency Plan and coordinates the facility's Emergency Response Team.

FIGURE 1: STL BURLINGTON ORGANIZATIONAL CHART

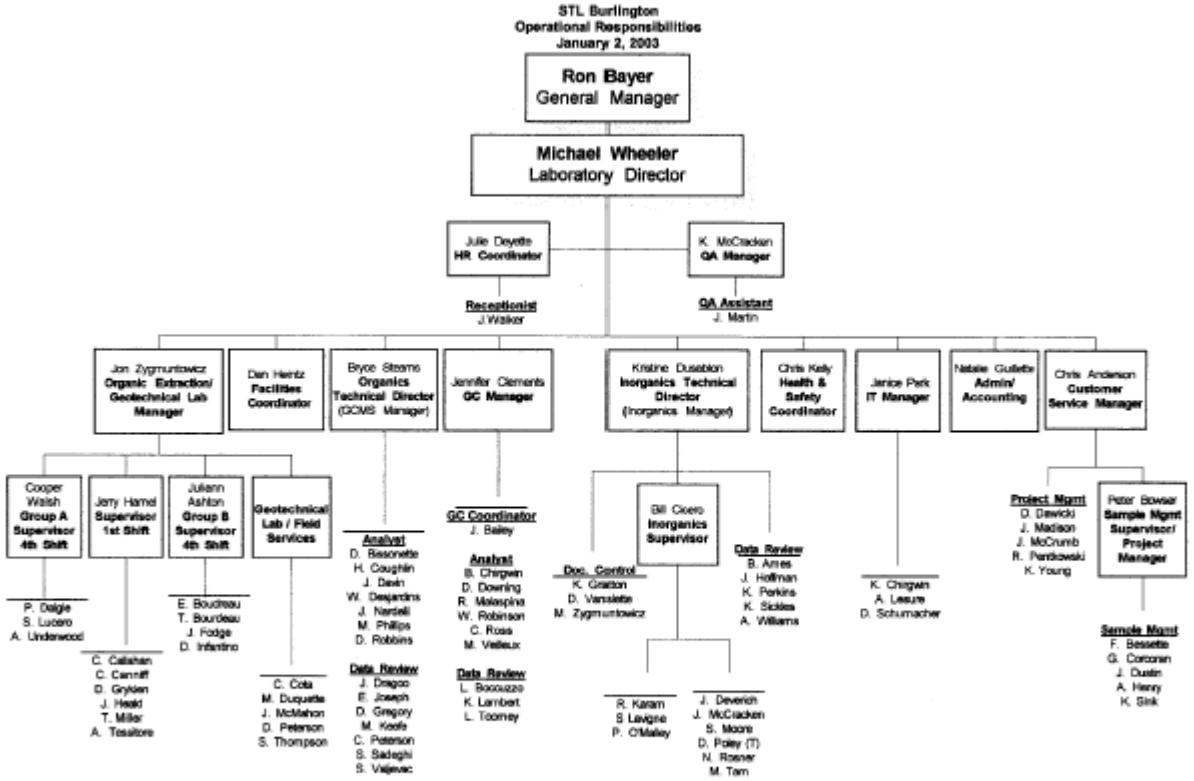
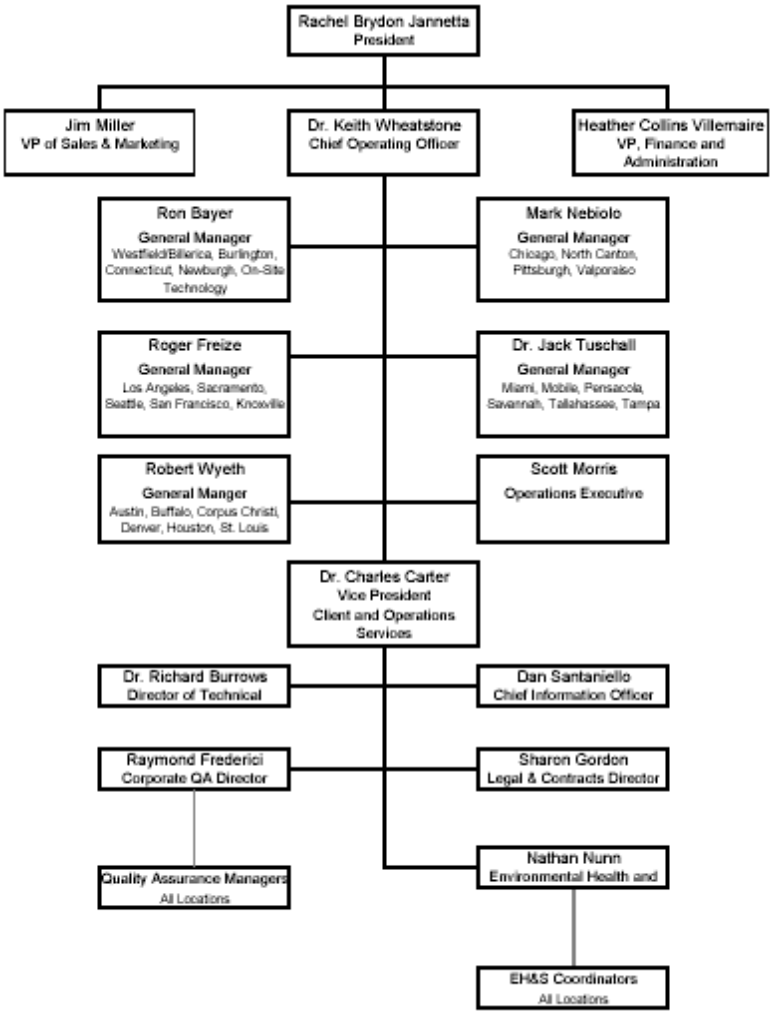


FIGURE 2: STL CORPORATE ORGANIZATIONAL CHART



4.2 Quality System

4.2.1 Objectives of the Quality System

The goal of STL Burlington's Quality System is to ensure that business operations are conducted with the highest standards of professionalism in the industry.

To achieve this goal, it is necessary to provide our clients with not only scientifically sound, well documented, and regulatory compliant data, but also to ensure that the laboratory provides the highest quality service available in the industry. A well-structured and well-communicated Quality System is essential in meeting this goal. The laboratory's Quality System is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

The STL Corporate Quality Management Plan (QMP) is the basis and outline for STL's Quality System and contains general guidelines under which all STL facilities conduct their operations. The Laboratory Quality Manual (LQM) describes the QA program at the laboratory and shall be compliant with the requirements of the QMP. Standard Operating Procedures (SOP) outline specific procedures for the implementation of the QA program and shall be compliant with the requirements of the QMP and the LQM.

4.2.2 Ethics Policy

Establishing and maintaining a high ethical standard is an important element of a Quality System. In order to ensure that all personnel understand the importance the company places on maintaining high ethical standards at all times; STL has established an Ethics Policy (P-L-006) and an Ethics Agreement (Figure 3). Each employee shall sign the Ethics Agreement, signifying agreed compliance with its stated purpose.

Violations of the Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary action up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize the Company's ability to do work on Government contracts, and for that reason, the Company has a Zero Tolerance approach to such violations.

Ethics is also a major component of the STL QA Training program. Each employee must be trained in ethics within three months of the hire. Employees must be trained as to the legal and environmental repercussions that result from data misrepresentation. A data integrity line is maintained by STL and administered by the STL QA Director.

FIGURE 3: STL ETHICS AGREEMENT

Severn Trent Laboratories, Inc.

EMPLOYEE ETHICS STATEMENT

I understand that STL is committed to ensuring the highest standard of quality and integrity of the data and services provided to our clients. I have read the Ethics Policy of the Company. With regard to the duties I perform and the data I report in connection with my employment at the Company, I agree that:

- I will not intentionally report data values that are not the actual values obtained;
- I will not intentionally report the dates, times, sample or QC identifications, or method citations of data analyses that are not the actual dates, times, sample or QC identifications, or method citations;
- I will not intentionally misrepresent another individual's work;
- I will not intentionally misrepresent any data where data does not meet Method or QC requirements. If it is to be reported, I will report it with all appropriate notes and/or qualifiers;
- I agree to inform my Supervisor of any accidental reporting of non-authentic data by me in a timely manner; and I agree to inform my Supervisor of any accidental or intentional reporting of nonauthentic data by other employees; and

- If a supervisor or a member of STL management requests me to engage in or perform an activity that I feel is compromising data validity or quality, I will not comply with the request and report this action immediately to a member of senior management, up to and including the President of STL.

As a STL employee, I understand that I have the responsibility to conduct myself with integrity in accordance with the ethical standards described in the Ethics Policy. I will also report any information relating to possible kickbacks or violations of the Procurement Integrity Act, or other questionable conduct in the course of sales or purchasing activities. I will not knowingly participate in any such activity and will report any actual or suspected violation of this policy to management.

The Ethics Policy has been explained to me by my supervisor or at a training session, and I have had the opportunity to ask questions if I did not understand any part of it. I understand that any violation of this policy subjects me to disciplinary action, which can include termination. In addition, I understand that any violation of this policy which relates to work under a government contract or subcontract could also subject me to the potential for prosecution under federal law.

EMPLOYEE SIGNATURE _____ Date _____

Supervisor/Trainer: _____ Date _____

4.3 Service to the Client

4.3.1 Request, Tender and Contract Review

For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental testing services to our clients. To ensure project success, technical staff shall perform a thorough review of technical and QC requirements contained in contracts. Contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements.

Contract review shall include a review of the client's requirements in terms of compound lists, test methodology requested, sensitivity, accuracy, and precision requirements. The laboratory Project Manager ensures that the laboratory's test methods are suitable to achieve these requirements and must ensure that the laboratory holds the appropriate certifications and approvals to perform the work. The review also includes the laboratory's capabilities in terms of turnaround time, capacity, and resources to provide the services requested, as well the laboratory's ability to provide the documentation, whether hardcopy or electronic. If the laboratory cannot provide all services but intends to subcontract such services, whether to another STL facility or to an outside firm, this must be documented and discussed with the client prior to contract approval.

All contracts entered into by STL Burlington shall be reviewed and approved by the appropriate personnel. Any contract requirement or amendment to a contract communicated to the laboratory verbally must be documented and confirmed with the client in writing. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. Contract amendments, initiated by the client and/or STL Burlington, are documented in writing for the benefit of both the client and the laboratory.

All contracts, Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the permanent project record.

4.3.2 Project Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site-specific testing programs. To achieve this goal, the laboratory shall assign a Project Manager (PM) to each client. The PM is the first point of contact for the client. It is the PM's responsibility to ensure that project specific technical and QC requirements are effectively communicated to the laboratory personnel before and during the project.

4.3.3 Data Quality Objectives

Data Quality Objectives (DQO) are qualitative and quantitative statements used to ensure the generation of the type, quantity, and quality of environmental data that will be appropriate for the intended application. Typically, DQOs are identified before project initiation, during the development of QAPPs and SAPs. The analytical DQOs addressed in this section are precision, accuracy, representativeness, completeness and comparability (PARCC).

The components of analytical variability (uncertainty) can be estimated when QC samples of the right types and at the appropriate frequency are incorporated into the measurement process. STL Burlington uses numerous QC samples to obtain data for comparison to analytical DQOs and to ensure that the measurement system is functioning properly. The QC samples and their application are selected based on regulatory, method or client specific requirements. QC samples for inorganic and organic analyses may include calibration blanks, instrument blanks, method blanks, laboratory control samples, calibration standards, matrix spikes, and surrogate spikes.

The DQOs discussed below ensure that data gathered and presented in accordance with procedures appropriate for its intended use, and that the data is of known and documented quality, and are able to withstand scientific and legal scrutiny.

Precision is an estimate of variability. It is an estimate of agreement among individual measurements of the same physical or chemical property, under prescribed similar conditions. Precision is expressed either as Relative Standard Deviation (RSD) for greater than two measurements or as Relative Percent Difference (RPD) for two measurements. Precision is determined, in part, by analyzing data from aggregate LCS results, MS, MSD, and MD. For radiochemical determinations, counting statistics can also provide an estimate of uncertainty.

Precision also refers to the measurement of the variability associated with the entire process, from sampling to analysis. Total precision of the process can be determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations.

Accuracy is the degree of agreement between a measurement and the true or expected value, or between the average of a number of measurements and the true or expected value. It reflects the total error associated with a measurement.

Both random and systematic errors can affect accuracy. For chemical properties, accuracy is expressed either as a percent recovery (R) or as a percent bias (R - 100). Accuracy is determined, in part, by analyzing data from LCS, MS, and MSD. For radiochemical determinations, counting statistics can also provide an estimate of uncertainty.

Representativeness is the degree to which data accurately and precisely represent a characteristic

of a population, a variation in a physical or chemical property at a sampling point, or an environmental condition. Data representativeness is primarily a function of sampling strategy; therefore, the sampling scheme must be designed to maximize representativeness. Representativeness also relates to ensuring that, through sample homogeneity, the sample analysis result is representative of the constituent concentration in the sample matrix. STL makes every effort to analyze an aliquot that is representative of the original sample, and to ensure the homogeneity of the sample before sub-sampling.

Completeness is defined as the percentage of measurements that are judged valid or useable. Factors negatively affecting completeness include the following: sample leakage or breakage in transit or during handling, loss of sample during laboratory analysis through accident or improper handling, improper documentation such that traceability is compromised, or sample result is rejected due to failure to conform to QC specifications. A completeness objective of greater than 90% of the data specified by the statement of work is the goal established for most projects.

Comparability is a measure of the confidence with which one data set can be compared to another. To ensure comparability, all laboratory analysts are required to use uniform procedures (e.g. SOPs) and a uniform set of units and calculations for analyzing and reporting environmental data.

4.3.4 Subcontracting

STL Burlington does not routinely subcontract analytical services with the exception of dioxin, asbestos, microbiological analyses, mammalian tissue sample preparation and radiological analyses. Subcontracting must be arranged with the documented consent of the client. All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. When required, the laboratory shall maintain proof of certification for the subcontract laboratory, and retain in the laboratory records. Where applicable, specific QC guidelines, QAPPs and/or SAPs are also given to the subcontract laboratory. Samples are subcontracted under formal Chain of Custody (COC).

Subcontract laboratories may receive an on-site audit by a representative STL's QA staff if it is deemed appropriate by the QA Manager. The audit involves a measure of compliance with the required test method, QC requirements, as well as any special client requirements. The originating laboratory may also perform a paper audit of the subcontractor, which would entail reviewing the LQM, the last two PT studies, and a copy of any recent regulatory audits with the laboratory's responses.

Intra-company subcontracting may also occur between STL facilities. Intra-company subcontracting within STL must be arranged with the documented consent of the client. The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs.

4.3.5 Client Confidentiality and Proprietary Rights

Data and sample materials provided by the client or at the client's request, and the results obtained by STL, shall be held in confidence (unless such information is generally available to the public or is in the public domain or client has failed to pay STL for all services rendered or is otherwise in breach of the terms and conditions set forth in the STL and client contract) subject to any disclosure required by law or legal process. STL's reports, and the data and information provided therein, are for the exclusive use and benefit of client, and are not released to a third party without written consent from the client.

4.3.6 Complaints

Client complaints shall be documented and addressed promptly and thoroughly. Client complaints are documented by the employee receiving the complaint and communicated to the Laboratory Director, Customer Service Manager, Project Manager and QA Manager, who assist in resolving the complaint.

The nature of the complaint is identified, investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA department shall conduct a special audit to assist in resolving the issue. A written confirmation, or letter to the client, outlining the issue and response taken is strongly recommended as part of the overall action taken. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Management Systems Review.

The laboratory procedures for handling complaints are further described in laboratory SOP AD-QA-004 *Complaint Resolution*.

4.4 Document Control

4.4.1 Document Type

The following documents, at a minimum, shall be document controlled in the laboratory:

- Laboratory Quality Manual (LQM)
- Standard Operating Procedures (SOP)
- Quality Management Plan (QMP)

4.4.2 Document Control Procedure

Security and control of documents is necessary to ensure that confidential information is not distributed and that all current copies of a given document are from the latest applicable revision.

Unambiguous identification of a controlled document is maintained by identification of the following items in the document header: Document Name, Document Number (if applicable), Revision Number, Effective Date, Number of Pages. Controlled documents are marked as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution. Controlled documents shall be available at all locations where the operational activity described in the document is performed. The laboratory procedures for document control are further described in laboratory SOP AD-QA-003 *Document Control.*

4.4.3 Document Revision

Quality system policies and procedures will be reviewed at a minimum of every two years and revised as appropriate. Changes to documents occur when a procedural change warrants a revision of the document. When an approved revision of a controlled document is ready for distribution, obsolete copies of the document shall be replaced with the current version of the document. The previous revision of the controlled document is archived by the QA Department.

4.5 Records

4.5.1 Record Types

There are five major record types defined by STL. The record types with examples of each record are given in Table 3.

Table 3: Record Types

Raw Data	Controlled Documents	QC Records	Project Records	Administrative Records
See Section 3 Terms and Definitions	LQM	Audit Reports Audit Response	Chain of Custody Documentation	Accounting
	QMP	Certifications	Contracts and Amendments	EH&S Manual, Permits, Disposal Records
	SOPs	Corrective Action	Correspondence	Employee Handbook
		Logbooks*	QAPP	Personnel files, Employee Signature & Initials, Training Records
		Method & Software Validation, Verification data	SAP	
		Standard Traceability	Telephone Logbooks	Technical and Administrative Policies

*Examples: Instrument Maintenance, Instrument Run Logs, Sample Preparation and/or Digestion Logs, Standard Preparation and Traceability Logs, Balance Calibration, etc.

4.5.2 Record Retention

Table 4 outlines the laboratory's standard record retention time. For raw data and project records, record retention is calculated from the date the project report is issued. For other records, such

as Controlled Documents, QC, or Administrative Records, the retention time is calculated from the date the document is formally retired.

Table 4: Routine Record Retention Time Frame

Record Type		Archival Requirement
Raw Data	All	10 Years from project completion
Controlled Documents	All	5 Years from document retirement date
QC	All	10 Years from archival
Project	All	5 Years from project completion
Administrative	Personnel/Training	7 years
Accounting	All	See Accounting and Control Procedures Manual

4.5.3 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the laboratory standard record retention time. In these cases, the longer retention requirement must be implemented and noted in the archive. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to whom to contact for authorization prior to destroying the data.

4.5.4 Archives and Record Transfer

Archives must be indexed such that records are accessible on either a project or temporal basis. Archives are protected against fire, theft, loss, deterioration, and vermin. Electronic records are protected from deterioration caused by magnetic fields and/or electronic deterioration. Access to archives is controlled and documented.

The laboratory ensures that all records are maintained as required by the regulatory guidelines and per the QMP upon facility location change or ownership transfer. Upon STL facility location change, all archives are retained by STL in accordance with the QMP. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established.

4.6 Control of Non-conformances

Non-conformances include any out of control occurrence and may relate to client specific requirements, procedural requirements, or equipment issues. All non-conformances in the laboratory shall be documented at the time of their occurrence.

All non-conformances that affect a sample and/or sample data become part of the affected project's permanent record. When appropriate, reanalysis is performed where QC data falls outside of specifications, or where data appears anomalous. If the reanalysis comes back within established tolerances, the results are approved. If the reanalysis is still outside tolerances, further reanalysis or consultation with the Client, Supervisor, Manager, PM, Laboratory Director, or QA Manager for direction may be required. All records of reanalysis are kept with the project files.

Where non-conformances specifically affect a client's sample and/or data, the client shall be informed and action must be taken. Action can take the form of reporting and flagging the data, and including the non-conformance in the project narrative or cover letter.

4.7 Corrective Action

Each corrective action is thoroughly investigated, and the investigation, outcome of the investigation, action taken and follow-up is documented. Corrective action reports are reviewed, approved and maintained by the QA department.

4.7.1 Initiation

Any laboratory employee who detects the need for corrective action is authorized to initiate a corrective action report. The initial source of corrective action can also be external to the laboratory (i.e. corrective action because of client complaint, regulatory audit, or proficiency test). When a problem that requires corrective action is identified, the initiator of the corrective action report identifies the following items: the nature of the problem, the name of the initiator, and the date. If the problem affects a specific client project, the name of the client and laboratory project number is recorded, and the PM is informed immediately.

4.7.2 Cause Analysis

The corrective action process must be embarked upon as a joint, problem solving, constructive effort. Identification of systematic errors, or errors that are likely to occur repetitively due to a defect or weakness in a system, is particularly valuable in maintaining an environment of continuous improvement in laboratory operations.

When a corrective action report is initiated, the initiator works with the affected employee(s) and/or department(s) to identify the root cause of the problem. An essential part of the corrective action process is to identify whether the problem occurred due to a systematic or isolated error.

If the initiator of the corrective action report is uncertain as to what would constitute appropriate corrective action or is unable to resolve the situation, the problem is identified to the Supervisor, Manager, Laboratory Director or the QA Manager who provides assistance in the corrective action process.

The root cause of the problem and associated cause analysis is documented on the corrective action form.

4.7.3 Corrective Action Taken

Once the root cause of a problem is identified, the initiator and affected employee(s) and/or department(s) examine potential actions that will rectify the present problem to the extent possible, and prevent recurrence of future, similar occurrences. An appropriate corrective action is then recommended. The corrective action must be appropriate for the size, and nature of the issue. If the corrective action concerns a specific project related issue, the PM approves the corrective action before its implementation. Implementation of the corrective action and the date of implementation are documented on the corrective action report.

Copies of the corrective action form are included in the project file. An essential part of the corrective action process is communication and awareness of the problem, the cause, and the action taken to prevent future occurrences and/or rectify the immediate problem.

4.7.4 Monitoring Corrective Action

All corrective action reports are maintained by the QA Department. The QA department reviews all corrective action reports and selects one or more of the significant corrective actions for inclusion in the annual systems audit. The QA Department also may implement a special audit. The purpose of inclusion of the corrective action process in both routine and special audits is to monitor the implementation of the corrective action and to determine whether the action taken has been effective in overcoming the issue identified.

4.8 Preventive Action

Preventative action is defined as noting and correcting a problem before it happens, because of a weakness in a system, method, or procedure. Preventative action includes analysis of the Quality System to detect, analyze, and eliminate potential causes of non-conformances. When potential problems are identified, preventative action is initiated to effectively address the problem to eliminate or reduce the risk identified.

4.9 Internal Audits

4.9.1 Audit Types and Frequency

There are several different types of audits performed by STL Burlington. Audit type and frequency are categorized in Table 5.

Table 5: Audit Types and Frequency

Audit Type	Performed by	Frequency
Systems	QA Department or Designee	Annual
Data	QA Department	5% of all projects or as agreed upon with Corporate QA Director
Special	QA Department or Designee	As Needed

4.9.2 Systems Audits

System audits are technical in nature and are conducted on an ongoing basis by the QA Manager or his/her designee. Systems audits cover all departments of the laboratory, both operational and support shall be performed following the procedures described in corporate SOP S-Q-002 *Systems Audits*.

The QA Manager should issue the audit report within 30 calendar days of the audit. The audit report is addressed to the Department Supervisor and/or Manager, and copied to the General Manager and Laboratory Director.

Written audit responses are required within 30 calendar days of audit report issue. The audit response follows the format of the audit report, and corrective actions and time frames for their implementation are included for each deficiency. The audit response is directed to all individuals copied on the audit report. Where a corrective action requires longer than 30 days to complete, the target date for the corrective action implementation is stated and evidence of the corrective action is submitted to the QA Department in the agreed upon time frame.

4.9.3 Data Audits

Data audits assess the level of customer service, method compliance, regulatory compliance, accuracy and completeness of test results and reports, documentation, and adherence to established QC criteria, laboratory SOPs, technical policy, and project specific QC criteria.

A data auditing frequency target of 5% has been established. The QA Department provides feedback and/or corrections and revisions to project reports where necessary. Data audits include spot-checking of manual integrations by QA personnel in order to determine that the manual integration is appropriate and documented according to laboratory policy.

Records of the data audits are kept, and the frequency of data audits shall be included in the monthly QA report. In performing data audits, it is essential that data be assessed in terms of differentiating between systematic and isolated errors. Upon noting anomalous data or occurrences in the data audits, the QA Department is responsible for seeking clarification from the appropriate personnel, ascertaining whether the error is systematic or an isolated error, and overseeing correction and/or revision of the project report if necessary. Errors found in client project reports are revised and the revision sent to the client. The QA Department is also

responsible for assisting in the corrective action process where a data audit leads to identification of the need for permanent corrective action.

4.9.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, proficiency testing results, data audits, systems audits, validation comments, or regulatory audits. Special audits are performed for a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

4.9.5 External Audits

STL Burlington is routinely audited by clients and external regulatory authorities. The laboratory is available for these audits and makes every effort to provide the auditors with the personnel, documentation, and assistance required by the auditors. STL Burlington recommends that the audits be scheduled with the QA Department so that all necessary personnel are available on the day of the audit.

4.10 Management Review

4.10.1 QA Reports to Management

A monthly QA report shall be prepared by the QA Manager and forwarded to the Laboratory Director, the GM, and the STL Corporate QA Director. The reports include statistical results and related information that are used to assess the effectiveness of the Quality System The format of the monthly QA report is specified by the STL Corporate QA Director.

A STL Corporate QA Monthly Report containing a compilation of the Facility QA reports statistics, information on progress of the Corporate QA program, and a narrative outlining significant occurrences and/or concerns is prepared by the STL Corporate QA Director and forwarded to the STL Chief Operating Officer.

4.10.2 Management Systems Review

A management systems review of the laboratory is performed at least annually by the QA Manager or her designee. The management systems review ensures that the laboratory's quality system is adequate to satisfy the laboratory's policies and practices, government requirements, certification, accreditation, approval requirements, and client expectations. Management systems reviews may be accomplished through monthly quality assurance reporting and goal setting.

5. Technical Requirements

5.1 Facilities

Access to the laboratory shall be secure, controlled and documented. Access is controlled by various measures including locked doors, electronic access codes and staffed reception areas. All visitors sign in and are escorted by laboratory personnel while in the facility.

STL Burlington has approximately 36,000 square feet of floor space that is used for analytical work and support staff. The facility is designed for efficient, automated high quality operations. The laboratory is equipped with Heating, Ventilation, and Air Conditioning (HVAC) systems appropriate to the needs of environmental testing laboratories. Environmental conditions, such as hood flow are routinely monitored and documented.

The laboratory is compliant with current Vermont Occupational Safety and Health Administration regulations and is equipped with unique environmental controls including air flow monitoring, solvent recovery, waste heat utilization, and building security systems. In addition, the laboratory is outfitted with instrumentation exhibiting advanced technology and automation. A list of instrumentation and supporting equipment can be found in Appendix C.

The laboratory facility has a reverse osmosis systems, centralized high purity water system and a computer networking and centralized gas distribution to support its analytical services.

STL Burlington is equipped with structural safety features. Each employee shall be familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory also provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc.

5.2 Purchasing Services and Supplies

Evaluation and selection of suppliers and vendors is done, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, all purchases from specific vendors are approved by a member of the supervisory or management staff.

Chemical reagents, solvents, gases, glassware and general supplies are ordered as needed to maintain sufficient quantities on hand. Purchasing guidelines for all equipment and reagents affecting data quality shall meet the requirements of the specific method and testing procedures

for which they are being purchased. Solvents and acids are pre-tested in accordance with the STL Corporate procedure S-T-001 *Testing of Solvents and Acids.*

5.3 Personnel

5.3.1 General

The management staff of STL Burlington believes that its highly qualified and professional staff is the single most important aspect in assuring the highest level of data quality service in the industry.

STL Burlington's staff consists of over sixty professionals and support personnel that include the following positions:

- General Manager
- Customer Service Manager
- Quality Assurance Manager
- Laboratory Director
- Technical Directors
- Section Manager
- Information Technology Manager
- Human Resources Coordinator
- Project Manager
- Analyst/Chemist
- Sample Custodian
- Data Review Specialist
- Information Technology Specialist

5.3.2 Training

The laboratory shall be committed to furthering the professional and technical development of employees at all levels.

Technical training is performed to ensure method comprehension. All new personnel shall be required to demonstrate competency in performing a particular method by successfully completing a Demonstration of Capability (DOC) before conducting analysis independently on client samples.

DOCs may be performed by analysis of four replicate QC samples. Results of successive LCS analyses can be used to fulfill the DOC requirement. The accuracy and precision, measured as average recovery and standard deviation (using n-1 as the population), of the 4 replicate results are calculated and compared to those in the test method or target criteria set by the laboratory. The laboratory sets the target criteria such that they reflect the data quality objectives of the

specific test method or project data quality objectives. A DOC Certification Statement is recorded and maintained in the employee's training file.

The following evidence must be on file at the laboratory for each technical employee:

- The employee has read and understood the latest version of the laboratory's quality documentation.
- The employee has read and understood the latest, approved version of all test methods and/or SOPs for which the employee is responsible.
- Initial Demonstration of Capability (IDOC)
- Annual evidence of continued proficiency that may include successful analysis of a blind sample for a specific test method, or a similar test method, an annual IDOC, or four successive, successful LCS.

5.4 Methodology

5.4.1 Method Selection

Most of the test methods performed at STL Burlington originate from test methods published by a regulatory agency such as the USEPA and other state and federal regulatory agencies. These include, but are not limited to, the following published compendiums of test methods:

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, USEPA, January, 1996.

Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water.

Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020),1983.

Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.

Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, August 1993.

Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992.

Statement of Work for Inorganics Analysis, ILM04.0-5.2, USEPA Contract Laboratory Program Multi-media, Multi-concentration.

Statement of Work for Organics Analysis, OLM03.2-4.3, USEPA Contract Laboratory Program, Multi-media, Multi-concentration.

Standard Methods for the Examination of Water and Wastewater, 18th/19th/20th edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.

Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996.

Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.

National Status and Trends Program, National Oceanographic and Atmospheric Administration, Volume I-IV, 1985-1994.

5.5 Method Validation and Verification Activities

Before analyzing samples by a particular method, method validation and/or method verification must occur. A complete validation of the method is required for methods developed by the laboratory. Method verification is required when a validated standard test method or a method modification is implemented. The level of activity required for method verification is dependent on the type of method being implemented, or on the level of method modification and its affect on a method's robustness. Method modification often takes advantage of a method's robustness, or the ability to make minor changes in a method without affecting the method's outcome. Method validation and verification may require some, but not all, of the following activities. Method validation and verification records are designated QC records and are archived accordingly.

Determination of Method Selectivity
Method selectivity should be demonstrated for the analyte (s) in the specific matrix or matrices. In some cases, to achieve the required selectivity for an analyte, a confirmation analysis may be required as part of the method.

Determination of Method Sensitivity
Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)
An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded.

The QL is the minimum level at which both the presence of an analyte and its concentration can be reliably determined. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

Determination of Reporting Limit (RL)

The method detection limit (MDL) is the approximate limit at which an analyte can be qualitatively detected using a specific method at a 99% confidence interval. The MDL is a statistically calculated value and measures the sensitivity of an entire method and is independent of device. The Reporting Limit (RL) or Limit of Quantitation is the limit at which a compound can be qualitatively detected and quantified at a 99% confidence interval. The RLs are set based on specific knowledge about the analyte, project specific requirements and/or regulatory requirements. The RL is always greater than the MDL is typically set based on 3-5 times the MDL.

For most methods the low calibration standard is set at the same concentration as the RL in order to monitor method sensitivity per instrument per calibration. Sample specific RLs are derived by taking into account various sample specific data, which can include the amount of the sample subject to testing, percent moisture, dilution factors, interferences and the base RLs for the analysis.

STL Burlington routinely reports results to the sample specific RLs. In some cases, it is appropriate to report values between the MDL and the RL. In this region, an analyte can be qualitatively detected, but not accurately quantified. Any data point reported in this region is flagged with "J" for organics and a "B" for inorganics to indicate that it is an estimated value.

Determination of Range

Where appropriate, a determination of the applicable range of the method is performed. In most cases, range is determined and demonstrated by comparison of the response of an analyte in a curve to established or targeted criteria. The curve is used to establish the range of quantitation and the lower and upper values of the curve represent upper and lower quantitation limits. Curves are not limited to linear relationships.

Determination of Interferences

A determination that the method is free from interferences in a blank matrix should be performed.

Demonstration of Capability
DOCs should be performed prior to method performance.

Determination of Accuracy and Precision
Accuracy and precision studies may be required as a separate determination from the DOC. Accuracy and precision studies are generally performed using four replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

Documentation of Method
The method should be formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, a SOP Appendix describing the specific differences in the new method is acceptable in place of a separate SOP.

Continued Demonstration of Method Performance
Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as Laboratory Control Samples and Method Blanks.

5.6 Standard Operating Procedures (SOPs)

SOPs shall be written for all routine technical and administrative activities performed in the laboratory. SOPs shall describe the analytical, QA/QC and operational protocol to be followed for each activity performed. Laboratory employees must follow the procedures written in the SOP for each activity being performed. Temporary deviations form an SOP may be necessary in order to meet the data quality objectives for a specific client or regulatory agency's request. If the departure is less stringent than the reference method, laboratory management must approve the change in procedure and the change must be documented in the project file.

In some cases, a standard laboratory procedure may be modified for a specific client or project at the client or regulatory agency's request. In these cases, an Appendix to the SOP may be attached that indicates the modifications to the SOP that are specific to that project. SOP appendices shall not be used to alter test methods required by regulation such that the modifications would result in non-compliance with the regulation.

STL Burlington maintains two different types of SOPs. Method SOPs describe a specific test method. Process SOPs describe function and processes not related to a specific test method. The QA Department is responsible for maintenance of SOPs, archival of historical revisions, and maintenance of a SOP index. SOPs, at a minimum, shall undergo review every 2 years. Where a SOP is based on a published method, the laboratory shall maintain a copy of the reference method. Both SOP Types shall include the following information on the first page:

Title Page with Document Name, Document Number, Revision Number, Effective Date, Page Numbers and Total # of Pages, Authorized Signatures, Dates and Proprietary Information Statement

5.6.1 Method SOPs

Method SOPs include the following information:

- Identification of Test Method
- Applicable Matrix
- Method Detection Limit
- Scope and Application, including test analytes
- Summary of the Test Method
- Definitions
- Interferences
- Safety
- Equipment and Supplies
- Reagents and Standards
- Sample Collection, Preservation, Shipment and Storage
- Quality Control
- Calibration and Standardization
- Procedure
- Calculations
- Method Performance
- Pollution Prevention
- Data Assessment and Acceptance Criteria for Quality Control Measures
- Corrective Actions for Out-of-Control Data
- Contingencies for Handling Out-of-Control or Unacceptable Data
- Waste Management
- References
- Tables, Diagrams, and Flowcharts

5.6.2 Process SOPs

Process SOPs may include some or all of the following information:

- Scope
- Summary
- Definitions
- Responsibilities
- Safety
- Procedure
- References
- Tables, Diagrams, and Flowcharts

5.7 Equipment Maintenance

STL Burlington employs a system of preventative maintenance in order to ensure system up time, minimize corrective maintenance costs and ensure data validity. All routine maintenance is performed as needed and as recommended by the manufacturer. Instrument maintenance may be performed by an analyst, instrument specialist or outside technician. Maintenance logbooks shall be kept on all major pieces of equipment in which both routine and non-routine maintenance is recorded. Notation of the date and maintenance activity is recorded each time service procedures are performed. The return to analytical control following instrument repair is documented in the maintenance logbook. Maintenance logbooks are retained as QC records.

Maintenance contracts may be held on specific pieces of equipment where outside service is efficient, cost-effective, and necessary for effective operation of the laboratory.

5.7.1 Equipment Verification and Calibration

All equipment shall be tested upon receipt to establish its ability to meet the QC guidelines contained in the test method for which the instrumentation is to be used. This testing shall be documented. Once an instrument is placed in routine service, ongoing instrument calibration is demonstrated at the appropriate frequency as defined in the test method. Any instrument that is deemed to be malfunctioning is clearly marked and taken out of service. When the instrument is brought back into control, this is documented in the instrument maintenance log.

5.7.2 Equipment Operation

STL Burlington is committed to routinely updating and automating instrumentation. The laboratory maintains state of the art instrumentation to perform the analyses within the QC specifications of the test methods. An Equipment List that includes the following information shall be maintained:

- Identity
- Date Installed
- Manufacturer's Name, Model Number, Serial Number
- Current Location
- Preventative Maintenance Schedule

All equipment is subject to rigorous checks upon its receipt, upgrade, or modification to establish that the equipment meets with the selectivity, accuracy, and precision required by the test method for which it is to be used. All manufacturer's operations and maintenance manuals are kept up to date and accessible for the use of the equipment operator. Documentation of equipment usage is maintained using analytical run and maintenance logbooks. A comprehensive list of major instrumentation, along with supporting equipment can be found in Appendix C.

5.7.3 Instrument Calibration

Calibration of instrumentation is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established reporting limits. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method.

Method specific SOP's discuss in detail how each instrument is calibrated, including frequency for calibration and re-calibration, and the source or grade of the calibration materials. The range of analyses performed and instrumentation utilized is extensive and the calibration procedures are instrument specific, varying from analysis to analysis. The calibration procedures for organics usually include an initial system performance check and some type of initial calibration (with a minimum of five calibration standards for most methods) with each analytical series. On-going and closing calibration checks are also included in most analytical series. For each type of calibration standard or performance check there are specific criteria to meet before sample analyses begin. These criteria are established in the methodologies as they are written in the referenced texts or by contract specifications.

Gas Chromatography/Mass Spectrometry (GC/MS)- Prior to analysis of samples, the instrument must be tuned with bromofluorobenzene (BFB) for volatile compounds and decafluorotriphenyl-phosphine (DFTPP) for semivolatile compounds or other tune criteria as specified by the method used. No samples are analyzed until the instrument has met the tuning criteria of the method.

In general, the instrument is then calibrated for all target compounds. An initial calibration curve is produced to define the working range to establish criteria for identification. The calibration is then verified using standards from an independent source. This initial calibration is evaluated on a daily basis to ensure that the system is within calibration. If the daily standard does not meet the established criteria, the system is re-calibrated.

Gas Chromatography- Each chromatographic system must be calibrated prior to analysis of samples. Initial calibration consists of determining the working range, establishing limits of detection, and establishing retention time windows. The calibration is then verified using standards from an independent source. The calibration is checked as required to ensure that the system remains within specifications. In addition, continuing calibrations are performed at frequencies required by the method used. If the calibration checks do not meet established criteria, corrective action which may include re-calibration and reanalysis of samples is taken.

*Metals- A*nalysis for metals generally involves two types of analytical instrumentation: inductively coupled argon plasma emission spectroscopy (ICP) and ICP-MS.

Each ICP must be calibrated prior to use by analyzing a multi-element calibration standard. The calibration is then verified using standards from an independent source. Alinear range verification check standard is analyzed and reported quarterly for each element analyzed by ICP.

This concentration is the upper limit of the ICP linear range and any result found above this limit must be diluted and reanalyzed. The calibration is monitored throughout the day by analyzing a Continuing Calibration Blank (CCB) and a Continuing Calibration Verification Standard (CCV). If the verification standard does not meet established criteria, corrective action is performed. For ICP-MS, prior to analysis of samples, the instrument must be tuned and no samples are analyzed until the instrument has met the tuning criteria of the method.

Wet Chemistry- The field of classical (wet) chemistry involves a variety of instrumental and wet chemical techniques. Calibration and standardization procedures vary depending on the system and analytical methodology required for a specific analysis. The calibration must be checked on an ongoing basis to ensure that the system remains within specifications. If the ongoing calibration check does not meet established criteria, analysis is halted and corrective action is taken. The procedures include examination of instrument performance and re-calibration and reanalysis of samples back to the previous acceptable calibration check.

5.8 Measurement Traceability

5.8.1 General

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy.

At a minimum, these must include procedures for checking specifications for balances, thermometers, temperature, de-ionized (DI) and reverse osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. With the exception of Class A Glassware (including glass microlitersyringes that have a certificate of accuracy), quarterly accuracy checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balances are calibrated on each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

Laboratory DI and RO water systems have documented preventative maintenance schedules and the conductivity of the water is recorded on each day of use.

Glassware Cleaning shall be described in laboratory SOPs and in some cases posted in the appropriate areas of the laboratory.

5.8.2 Reference Standards

All standard reference materials should be purchased with an accompanying Certificate of Analysis that documents the standard purity, when available. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard should be documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique identification number, date received, and the expiration date. All documentation received with the reference standard is retained as a QC record.

The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a different lot is acceptable for use as a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or Laboratory Control Sample (LCS) is used as the second source confirmation.

5.8.3 Reagents

Reagents are, in general, required to be analytical reagent grade unless otherwise specific in method SOPs. Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the date the reagent was opened are documented.

5.9 Sampling

Sample representativeness and integrity are the foundations upon which meaningful analytical results rely. Where documented and approved SAPs and/or QAPPs are in place, they must be made available to the laboratory before sample receipt, and approved by laboratory management before sample receipt.

5.9.1 Sample Acceptance Policy

The laboratory maintains a sample acceptance policy that describes compromised sample receipt. Samples are considered “compromised” if the following conditions are observed upon sample receipt:

- Cooler and/or samples are received outside of temperature specification.
- Samples are received broken or leaking.
- Samples are received beyond holding time.
- Samples are received without appropriate preservative.
- Samples are received in inappropriate containers.
- COC does not match samples received.
- COC is not properly completed or not received.
- Breakage of any Custody Seal.

- Apparent tampering with cooler and/or samples.
- Headspace in volatiles samples.
- Seepage of extraneous water or materials into samples.
- Inadequate sample volume.
- Illegible, impermanent, or non-unique sample labeling.

When "compromised" samples are received, it must be documented in the project records and the client must be contacted for instructions. If the client decides to proceed with analysis, the project report shall clearly indicate any of the above conditions and the resolution.

5.10 Sample Handling, Transport, and Storage

5.10.1 General

Chain of Custody (COC) may be established either when bottles are sent to the field, or at the time of sampling. STL Burlington can provide all of the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory.

Samples are received at the laboratory by a designated sample custodian and a unique Laboratory Project Identification Number is assigned. The following information is recorded for each sample shipment: Client/Project Name, Date and Time of Laboratory Receipt, Laboratory Project Number, and Signature or initials of the personnel receiving the cooler and making the entries.

Upon inspection of the cooler and custody seals, the sample custodian opens and inspects the contents of the cooler, and records the cooler temperature. All documents are immediately inspected to assure agreement between the test samples received and the COC.

Any non-conformance, irregularity, or compromised sample receipt must be documented and brought to the immediate attention of the PM for resolution with the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the permanent project record.

Samples that are being tested at another STL facility or by an external subcontractor shall be repackaged, iced, and sent out under COC.

Following sample labeling, the sample is placed in storage. Sample storage shall be access controlled. All samples are stored according to the requirements outlined in the test method, and in a manner such that they are not subject to cross contamination or contamination from their environment. Unless specified by method or state regulation, a temperature range of $4 \pm 2^{o}C$ is used. Sample storage temperatures are monitored daily.

5.10.2 Sample Identification and Traceability

The laboratory uses a custom designed Laboratory Information Management System (LIMS) to uniquely identify and track samples and analytical data throughout the facility. Each sample container shall be assigned a unique Sample Identification Number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with the sample identification label.

5.10.3 Sub-sampling

Where sub-sampling (as in obtaining sample aliquots from a submitted sample) is performed the laboratory shall use approved laboratory standard operating procedures to ensure representative sub-samples.

5.10.4 Sample Preparation

Samples are prepared according to standardized method following approved laboratory standard operating procedures.

5.10.5 Sample Disposal

STL Burlington retains samples, digestates and extracts 30days after the project report is sent unless prior written arrangements have been made with the client. Some samples are required to be held for longer periods based on regulatory or client requirements. The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Samples may be returned to the client per written request. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

Samples shall be disposed of in accordance with federal, state and local regulations. The laboratory procedures for sample disposal are further described in the laboratory SOP for *Hazardous Waste Disposal*.

5.11 Assuring the Quality of Test Results

5.11.1 Control Samples

Control samples are analyzed with each batch of samples to monitor laboratory performance in terms of accuracy, precision, sensitivity, selectivity, and interferences. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch. There are also a number of QC sample types that monitor field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Control Sample types and typical frequency of their application are

outlined in Table 6. Note that frequency and use of control samples vary with specific regulatory, methodology and project specific criteria. The quality control program implemented in the laboratory includes the analysis of method blanks, check standards, laboratory control samples, analytical spikes, and surrogate spikes. Depending on the analysis, every analytical series includes one or more of these controls. Additional types of quality control are performed as necessary.

5.11.2 Development of QC Criteria, Non-Specified in Method/Regulation

Where a method or regulation does not specify acceptance and/or rejection criteria, the laboratory must address the data user's needs and the demonstrated sensitivity, accuracy and precision of the available test methods in determining appropriate QC criteria.

Data users often need the laboratory's best possible sensitivity, accuracy, and precision using a routinely offered test method, or are unsure of their objectives for the data. For routine test methods that are offered as part of the laboratory's standard services, the laboratory bases the QC criteria on statistical information such as determination of sensitivity, historical accuracy and precision data, and method verification data. The method SOP includes QC criteria for ongoing demonstration that the established criteria are met (i.e. acceptable LCS accuracy ranges, precision requirements, method blank requirements, initial and continuing calibration criteria, etc.).

In some cases, a routine test method may be far more stringent than a specific data user's needs for a project. The laboratory may either use the routinely offered test method, or may opt to develop an alternate test method based on the data user's objectives for sensitivity, accuracy, and precision. In this case, it can be appropriate to base the QC criteria on the data user's objectives, and demonstrate through method verification and ongoing QC samples that these objectives are met.

For example, a client may require that the laboratory to test for a single analyte with specific DQOs for sensitivity, accuracy, and precision as follows: Reporting Limit of 10 ppm, accuracy $\pm$25%, and RSD of less than 30%. The laboratory may opt to develop a method that meets these criteria and document through the Method blank results, MDL study, and LCS results that the method satisfies those objectives. In this case, both the method and the embedded QC criteria have been based on the client's DQOs.

In some cases, the data user needs more stringent sensitivity, accuracy, and/or precision than the laboratory can provide using a routine test method. In this case, it is appropriate that the laboratory provide documentation of the sensitivity, accuracy, and precision obtainable to the data user and let the data user determine whether to use the best available method offered by the laboratory, or determine whether method development or further research is required.

Table 6: Control Samples

Laboratory QC Sample Type	Use	Typical Frequency
Laboratory Control Sample (Laboratory Fortified Blank)	Measures accuracy of method in blank matrix	1 per batch of 20 or less samples per matrix type per sample extraction or preparation method
Method Blank	Measures method contribution to any source of contamination	1 per batch of 20 or less samples per matrix type per sample extraction or preparation method
Instrument Blank	Measures instrumental contribution to any source of contamination	As specified in test method
Cleanup Blank	Measures clean up step contribution to any source of contamination	As specified in test method
Storage Blank	Measures storage contribution to any source of contamination (Volatiles only)	As specified in test method or SOP
Control, Brine Control, or Dilution Water	Measures effect of blank water on test organisms (Aquatic toxicology)	As specified in test method and permit
Field QC Sample Type	**Use**	**Typical Frequency**
Matrix Duplicate	Measures effect of site matrix on precision of method	Per 20 samples per SAP/QAPP[1,2]
Matrix Spike	Measures effect of site matrix on accuracy of method	Per 20 samples per SAP/QAPP[1]
Matrix Spike Duplicate	Measures effect of site matrix on precision of method	Per 20 samples per SAP/QAPP[1,2]
Equipment Blank (Equipment Rinsate)	Measures field equipment contribution to any source of contamination	Per SAP/QAPP
Trip Blank	Measures shipping contribution to any source of contamination (Volatiles)	Per Cooler
Field Blank	Measures field environment contribution to any source of contamination	Per SAP/QAPP
Field Duplicate	Measures representativeness of sampling and effect of site matrix on precision	Per SAP/QAPP

[1] Denotes an STL required frequency
[2] Either an MSD or an MD is required per 20 samples per matrix or per SAP/QAPP.

5.11.3 Proficiency Testing (PT)

STL Burlington shall analyze Proficiency Test (PT) samples as required for certification and accreditation. As required by the National Environmental Laboratory Accreditation Conference (NELAC), the laboratory participates in the PT program semi-annually for each PT field of testing for which it is accredited; according to the NELAC PT field of testing published guidelines. Under SDWA, the laboratory also analyzes a PT sample by each method once per year, if the laboratory uses more than one method for the analyte.

In addition to the PT program required for NELAC accreditation, STL Burlington participates in a number of additional PT programs, as appropriate for a particular project or regulatory program.

PT samples must be handled and tested in the same manner (procedural, equipment, staff) as environmental samples. PT test sample data is archived using the requirements for project and raw data record retention.

STL Burlington participates in a double blind performance evaluation annually that is coordinated by the STL Corporate QA Director. An external vendor is contracted to submit double blind samples to the STL facility. Both the level of customer service and the accuracy of the test results are assessed objectively by the external contractor, who provides a detailed report to the Corporate QA Director and to the laboratory. The report is used to assess all facets of STL operations.

5.13 Data review

All data, regardless of regulatory program or level of reporting, shall be subject to a thorough review, which involves a primary, secondary, and completeness review process (tertiary). All levels of the review shall be documented.

5.13.1 Primary Review

The primary review is often referred to as a “bench-level” review. In most cases, the analyst who generates the data (i.e. logs in, prepares and/or runs the samples) is the primary reviewer. In some cases, an analyst may be reducing data for samples run by an auto-sampler set up by a different analyst. In this case, the identity of both the analyst and the primary reviewer is identified in the raw data.

One of the most important aspects of primary review is to make sure that the test instructions are clear, and that all project specific requirements have been understood and followed. If directions to the analyst are not clear, the analyst must go to the Supervisor, Manager, or PM, who must clarify the instructions.

Once an analysis is complete, the primary reviewer ensures that:

- Sample preparation information is complete, accurate, and documented.
- Calculations have been performed correctly.
- Quantitation has been performed accurately.
- Qualitative identifications are accurate.
- Manual integrations are appropriate.
- Data flags are present to indicate manual integrations are recorded.
- Manual integrations are authorized by date and signature/ initials of primary analyst.
- Client specific requirements have been followed.
- Method and process SOPs have been followed.
- Method QC criteria have been met.
- QC samples are within established limits.
- Dilution factors are correctly recorded and applied.
- Non-conformances and/or anomalous data have been properly documented and appropriately communicated.
- COC procedures have been followed.
- Primary review is documented by date and initials/signature of primary analyst.

Any anomalous results and/or non-conformances noted during the Primary Review are communicated to the PM for resolution. Resolution can require sample reanalysis, or it may require that data be reported with a qualification.

5.13.2 Secondary Review

The secondary review shall be a complete technical review of a data set. The secondary review must be documented and the secondary reviewer identified. The following items are reviewed:

- Qualitative Identification
- Quantitative Accuracy
- Calibration
- QC Samples
- Method QC Criteria
- Adherence to method and process SOPs
- Accuracy of Final Client Reporting Forms
- Manual Integrations – Minimal requirement is to spot-check raw data files for manual integration, as verified by date and initials or signature of secondary data reviewer. Some regulatory programs require 100% secondary review of manual integrations.
- Completeness
- Special Requirements/Instructions

If problems are found during the secondary review, the reviewer must work with the appropriate personnel to resolve them. If changes are made to the data, such as alternate qualitative identifications, identifications of additional target analytes, re-quantitation, or re-integration, the secondary reviewer must contact the laboratory analyst and/or primary reviewer of the data so that the primary analyst and/or reviewer is aware of the appropriate reporting procedures.

5.13.3 Completeness Review

The completeness review shall include the generation of a project narrative and/or cover letter which outlines anomalous data and non-compliances using project narrative notes and non-compliance reports generated during the primary and secondary review. The completeness review addresses the following items:

- Is the project report complete?
- Does the data meet with the client's expectations?
- Were the data quality objectives of the project met?
- Are QC outages and/or non-conformances approved and appropriately explained in the narrative notes?

5.14 Project Reports

5.14.1 Project Report Format

STL Burlington offers a wide range of project report formats, including EDDs, short report formats, and complete data deliverable packages modeled on the Contract Laboratory Protocol (CLP). At a minimum each project report shall include the following information:

- Title
- Laboratory name, address, telephone number, contact person
- Unique Laboratory Project Number
- Total Number of Pages
- Name and address of Client
- Client Project Name (if applicable)
- Laboratory Sample Identification
- Client Sample Identification
- Matrix and/or Description of Sample
- Test Method
- Dates: Sample Receipt, Collection, Preparation and/or Analysis Date
- Definition of Data Qualifiers
- Reporting Units

The following items are required where applicable to the specific test method or matrix:

- Solid Samples: Indicate Dry or Wet Weight
- Whole Effluent Toxicity: Statistical package used
- If holding time $\leq$ 48 hours, Sample Collection, Preparation and/or Analysis Time
- Indication by flagging where results are reported below the quantitation limit.

5.14.2 Project Narrative

A Project Narrative and/or Cover Letter shall be included with each project report and at a minimum includes an explanation of any and all of the following occurrences:

- Non-conformances
- "Compromised" sample receipt (see Section 4.7.1)
- Method Deviations
- QC criteria failures

5.14.3 Project Release

The Laboratory Director or his/her designee must authorize the release of the project report with a signature.

Where amendments to project reports are required after issue, these shall be in the form of a separate document and/or electronic data deliverable. The revised report is clearly identified as revised with the date of revision and the initials of the person making the revision. Specific pages of a project report may be revised using the above procedure with an accompanying cover letter indicating the page numbers of the project revised. The original version of the project report must be kept intact and the revisions and cover letter included in the project files.

5.14.4 Subcontractor Test Results

Project reports from external subcontract shall not be altered, and shall be included in original form in the final project report provided by STL Burlington. Data from subcontractors' reports may be added to the laboratory's electronic deliverable.

Subcontracted data shall be clearly identified as such, and the name, address, and telephone number for the laboratory performing the test is included in the project report. If the report is being generated under NELAC requirements, all information outlined in section 5.14.1 are required for both the originating laboratory and the subcontracting laboratory.

Data subcontracted within STL may be reported on the originating laboratory's report forms provided the following mandatory requirements are met:

- The name, address, and telephone number of the facility are provided.
- Analytical results produced by the STL intra-company subcontractor are clearly identified as being produced by the subcontractor facility.
- The intra-company subcontractor's original report, including the chain of custody is retained by the originating laboratory.
- Proof of certification and accreditation is retained by the originating laboratory.

5.15.5 Electronic Data Deliverables

Electronic Data Deliverables (EDD) are routinely offered as part of STL Burlington'sservices. The laboratory offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), New Agency Standard (NAS), Format A, Excel, Dbase, GISKEY, and Text Files.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process in Section 4.4.1. Once the facility has committed to providing diskettes in a specific format, the coding of the format is performed. This coding is documented and validated. The validation of the code is retained as a QC record.

EDDs shall be subject to a secondary review to ensure their accuracy and completeness.

5.16 Data Integrity and Security

This section details those procedures that are relevant to computer systems that collect, analyze, and process raw instrumental data, and those that manage and report data. Additional procedures for data integrity and security are further described in the laboratory's Information Quality Systems Manual (IQSM).

5.16.1 Security and Traceability

Access to computer systems that collect, analyze, and process raw instrumental data, and those that manage and report data must be both controlled and recorded. There are various systems at the laboratory to which this applies, which include the Laboratory Information Management System (LIMS), as well as specific systems such as a chromatography data system.

Control of the system is accomplished through limitation of access to the system by users with the education, training and experience to knowledgeably and accurately perform the task. System users are granted privileges that are commensurate with their experience and responsibilities.

Computer access is tracked by using unique login names and passwords for all employees that have access to the computer system. "General" or "multi-user" account access to computer systems that collect, analyze and process raw instrumental data, and those that manage and report

data shall not be permitted. Entries and changes are documented with the identity of the individual making the entry, and the time and date. Where a computer system is processing raw instrumental data, the instrument identification number is recorded. Many of these systems, such as the Target® Data System, have the capability of maintaining audit trails to track entries and changes to the data. This function shall be activated on any computer system that has that capability.

5.16.2 Software Verification

All commercially obtained software shall be verified prior to use and after version upgrade. Verification involves assessing whether the computer system accurately performs its intended function. Verification generally is accomplished by comparing the output of the program with the output of the raw data manually processed, or processed by the software being replaced. The records of the verification are required to contain the following information: software vendor, name of product, version, comparison of program output and manual output, raw data used to verify the program, date, and name of the individual performing the verification. Records of verification are retained as Information Technology (IT) QC records.

5.16.3 Software Validation

Software validation involves documentation of specifications and coding as well as verification of results. Software validation is performed on all in house programs. Records of verification include original specifications, identity of code, printout of code, software name, software version, name of individual writing the code, comparison of program output with specifications, and verification records as specified above. Records of validation are retained as IT records.

5.16.4 Auditing

The QA Department systems audit includes review of the control, security, and tracking of IT systems and software.

5.16.5 Version Control

The laboratory maintains copies of outdated versions of software and associated manuals for all software in use at the laboratory for a period of five years from its retirement date.

Appendix A
List of Analytical Capabilities

Appendix A
Analytical Capabilities
(Effective February 5, 2003)

Reference	Method	Description
40CFR136	601/602	Aromatic and Chlorinated Volatile Organics
40CFR136	608	Organochlorine Pesticide & PCBs
40CFR136	615	Chlorinated Herbicides
40CFR136	624	GC/MS Volatile Organics
40CFR136	625	GC/MS Semivolatile Organics
40CFR136	1624	GC/MS Volatile Organics, Isotope Dilution
40CFR136	1624	1624 Vacuum Distillation, Isotope Dilution
40CFR136	1625	GC/MS Semivolatile Organics, Isotope Dilution
40CFR141	502.2	GC Volatile Organics, Drinking Water
40CFR141	504.1	EDB and DBCP
40CFR141	524.2	GC/MS Volatile Organics, Drinking Water
40CFR141	508	Organochlorine Pesticide & PCBs
ASTM	D4318-93	Liquid Limit, Plastic Limit, Plasticity
ASTM	D854	Specific Gravity
ASTM	D2216	Water (Moisture) Content of Soil and Rock
ASTM	D2217	Wet Prep for Particle Size
ASTM	D421	Dry Prep for Particle Size
ASTM	D422	Particle Size Analysis
ASTM	D1946-90	Fixed Gases in Air
CAA	TO14A (MOD)	Volatile Organic Compounds in Ambient Air by GCMS
CAA	TO15 (MOD)	Volatile Organic Compounds in Ambient Air by GCMS
CAA	375.4 (MOD)	Sulfate on Filters
CAA	353.2 (MOD)	Nitrate/Nitrite-N on Filters
EPA CLP	ILM04.1	Cyanide, Total
EPA CLP	ILM04.1	ICP Metals Analysis
EPA CLP	ILM04.1	Mercury by Cold Vapor
EPA CLP	ILM05.2	Cyanide, Total
EPA CLP	ILM05.2	ICP Metals Analysis
EPA CLP	ILM05.2	Mercury by Cold Vapor
EPA CLP	OLC02.1	GC/MS Volatile Organics, Low Concentration
EPA CLP	OLC02.1	GC/MS Semivolatile Organics, Low Concentration
EPA CLP	OLC02.1	Organochlorine Pesticide & PCBs, Low Concentration
EPA CLP	OLM03.2	GC/MS Volatile Organics
EPA CLP	OLM03.2	GC/MS Semivolatile Organics
EPA CLP	OLM03.2	Organochlorine Pesticide & PCBs
EPA CLP	OLM04.2	GC/MS Volatile Organics
EPA CLP	OLM04.2	GC/MS Semivolatile Organics
EPA CLP	OLM04.2	Organochlorine Pesticide & PCBs
EPA CLP	OLM04.3	GC/MS Volatile Organics
EPA CLP	OLM04.3	GC/MS Semivolatile Organics
EPA CLP	OLM04.3	Organochlorine Pesticide & PCBs
EPA SW-846	1010	Ignitability (F)
EPA SW-846	1311	Toxicity Characteristic Leaching Procedure
EPA SW-846	1312	Synthetic Precipitation Leaching Procedure
EPA SW-846	1320	Multiple Extraction Procedure

Reference	Method	Description
EPA SW-846	6010B	ICP Metals
EPA SW-846	6020	ICP Metals
EPA SW-846	6010B	Sulfur by ICP (Waters)
EPA SW-846	6010B_TCLP	ICP Metals, TCLP Leachate
EPA SW-846	7196A	Hexavalent Chromium
EPA SW-846	7470A	Mercury by Cold Vapor
EPA SW-846	7471A	Mercury by Cold Vapor
EPA SW-846	8015_GAS	TPH- Gasoline
EPA SW-846	8015_DIESEL	TPH- Diesel & Motor Oil
EPA SW-846	8021	GC Aromatic and Halogenated Volatile Organics
EPA SW-846	8081A	Organochlorine Pesticide & PCBs
EPA SW-846	8081A_TCLP	TCLP Organochlorine Pesticides
EPA SW-846	8082	GC PCB
EPA SW-846	8082	GC PCB Congeners
EPA SW-846	8141A	Organophosphorus Pesticides
EPA SW-846	8151A	Herbicides
EPA SW-846	8151A_TCLP	TCLP Herbicides
EPA SW-846	8260B	GC/MS Volatile Organics
EPA SW-846	8260B	GC/MS Low Level Volatile Organics
EPA SW-846	8270C	GC/MS Semivolatile Organics
EPA SW-846	8330	HPLC Explosives
EPA SW-846	9038	Total Sulfate
EPA SW-846	9056	Inorganic Anions by Ion Chromatography
EPA SW-846	9060	Total Organic Carbon
EPA SW-846	9065	Total Phenols
EPA SW-846	9081	Cation-Exchange Capacity
EPA SW-846	9012A	Total Cyanide
EPA SW-846	9030B/9034	Sulfide
EPA SW-846	9040B	pH (std. units)
EPA SW-846	9045C	Soil pH (std. Units)
EPA SW-846	9250	Chloride, Total
EPA SW-846	9095A	Paint Filter Liquids Test
EPA SW-846	Sec. 7.3.3.	Reactive Cyanide
EPA SW-846	Sec. 7.3.4.	Reactive Sulfide
In house	IN623	Percent Solids
In house	In house	Explosive Aqueous Sample Screen
In house	In house	Explosive Soil Screen: TNT and RDX
In house	OLM_SAT	Low Level Organochlorine Pesticide & PCBs
In house	OR560	Alkyl Tin Analysis
In house	NOAA	GC/MS SIM PAHs
In-house	RSK-175	Dissolved Gases in Groundwater
Lloyd Khan	Lloyd Khan	Total Organic Carbon in Soil
MCAWW	110.1	Color
MCAWW	120.1	Conductivity/Salinity
MCAWW	130.2	Total Hardness as CaCO3
MCAWW	150.1	pH (std units)
MCAWW	160.1	Total Dissolved Solids
MCAWW	160.2	Total Suspended Solids
MCAWW	160.3	Total Solids
MCAWW	160.4	Volatile Total Solids

Reference	Method	Description
MCAWW	160.5	Settleable Solids (ml/l)
MCAWW	180.1	Turbidity (NTU)
MCAWW	200.7	Metals
MCAWW	300.0	Inorganic Anions by Ion Chromatography
MCAWW	310.1	Alkalinity (as CaCO3)
MCAWW	325.2	Chloride
MCAWW	340.2	Fluoride
MCAWW	350.2	Ammonia Nitrogen
MCAWW	351.3	Total Kjeldahl Nitrogen
MCAWW	353.2	Nitrate/Nitrite Nitrogen
MCAWW	354.1	Nitrite Nitrogen
MCAWW	360.2	Dissolved Oxygen
MCAWW	365.2:ORTH	Orthophosphate as P
MCAWW	365.2:TOTL	Total Phosphate as P
MCAWW	375.4	Sulfate
MCAWW	376.2	Sulfide
MCAWW	377.1	Sulfite
MCAWW	405.1	BOD5
MCAWW	410.1	COD
MCAWW	413.1	Oil and Grease
MCAWW	413.2	Oil and Grease
MCAWW	415.1	Total Organic Carbon
MCAWW	418.1	Petroleum Hydrocarbons
MCAWW	420.1	Total Phenols
MCAWW	425.1	MBAS (mg LAS/L)
MCAWW	245.1	Mercury by Cold Vapor
MCAWW/SW-846	335.1, 335.2	Cyanide, Total and Amenable
MCAWW/SW-846	450.1	Total Organic Halides
Standard Methods	4500G	Dissolved Sulfide in Soil
Standard Methods	3500FE	Ferrous Iron (Phenanthroline Method)
Standard Methods	4500FC	Fluoride by Ion Selective Electrode
Standard Methods	4500PE	Ortho Phosphate as P
Standard Methods	4500CNG/CNE	Cyanide, Total and Amenable
Standard Methods	4500NO2B	Nitrite Nitrogen
Standard Methods	2540C	Total Dissolved Solids
Standard Methods	2510B	Conductivity
Standard Methods	2320B	Alkalinity (as CaCO3)
Standard Methods	5210 (MOD)	Carbonaceous BOD
State of MA	EPH	EPH for MA
State of MA	VPH	VPH for MA
Status and Trends	SATPPCB	Status and Trends Pest/Congener

Appendix B
List of Laboratory Certification & Accreditation

Appendix B
List of Certifications and Accreditations
(Effective February 5, 2003)

State of Connecticut Department of Health Services
Certificate Number PH-0751
Contact Person: Mr. Nicholas Macelletti
Phone Number: 203-566-4045

Florida Department of Health and Rehabilitative Services
NELAC Accreditation (Primary/Secondary)
Certificate Number: E87467 and 87751
Contact Person: Mr. Steve Arms
Phone Number: 904-359-6456

State of Maine Department of Human Services
Certificate ID: VT008
Contact Person: Mr. Michael Sodano
Phone Number: 207-287-1929

The Commonwealth of Massachusetts Department of Environmental Protection
Laboratory ID Number: M-VT008
Contact Person: Ms. Lisa Touet
Phone Number: 978-682-5237

New Jersey Department of Environmental Protection and Energy
NELAC Accreditation (Primary/Secondary)
Laboratory ID Number: VT972
Contact Person: Mr. Andrew Fishman
Phone Number: 609-633-2804

State of New Hampshire Department of Environmental Services
NELAC Accreditation (Secondary)
Certificate Number: 200601-A
Contact Person: Mr. Charles Dyer
Phone Number: 603-271-3503

New York State Department of Health
NELAC Accreditation (Primary)
Lab ID Number: 10391
Contact Person: Mr. Matthew Caruso
Phone Number: 518-485-5570

Appendix B (Continued)
List of Certifications and Accreditations
(Effective February 5, 2003)

State of Pennsylvania Department of Environmental Resources
NELAC Accreditation (Secondary)
Lab ID Number: 68-489
Contact Person: Mr.Richard Sheibly
Phone Number: 717-787-6045

State of Rhode Island and Providence Plantations Department of Health
License Number: 81
Contact Person: Ms. Ewa King, Ph.D.
Phone Number: 401-222-1999

Vermont Department of Health Laboratory
Certification ID: VT-39000
Contact Person: Mr. George Mills
Phone Number: 802-863-7335

The Naval Facilities Engineering Service Center (NFESC)
Contact Person: Pati Moreno
Phone Number: 805 982-1659

United States Army Corps of Engineers
Contact Person: Lab Validation Coordinator
Phone Number: 402-697-2574

Appendix C
Major Equipment Listing

STL Burlington Equipment List Summary

(Effective January 31, 2003)

Department	Number	Description
GC/MS Volatiles	2	GC/MSD Purge & Trap, Liquid Autosampler
	3	GC/MSD Purge & Trap, Liquid/Soil Autosampler
GC/MS Semivolatiles	6	GC/MSD, Liquid Autosampler
GC Volatiles	1	GC/PID (dual) ELCD (dual), Purge & Trap, Liquid Autosampler
	1	GC/FID, Purge & Trap, Liquid Autosampler
	1	GC/PID ELCD, Purge & Trap, Liquid Autosampler
Air	2	GC/MSD, Concentrator
	1	GC/FID-TCD, Headspace Autosampler
	2	Summa Can Cleaning System
GC/HPLC	4	HPLC w/ UV, Liquid Autosampler
	2	Photodiode Array Detectors
	11	GC/ECD (dual), Liquid Autosampler
	2	Hydrogen Generators
	2	GC/FPD (dual), Liquid Autosampler
	3	GC/FID (2 dual, 1 single), Liquid Autosampler
	1	GC FID/ELCD, Liquid Autosampler
Metals	3	Trace ICP, Liquid Autosampler
	1	ICP/MS, Liquid Autosampler
	3	Hg CVAA Analyzers, Liquid Autosampler
Wet Chemistry	2	Flow Injection Analyzers, Liquid Autosampler
	1	TOC Analyzer (Liquid), Liquid Autosampler
	1	Ion Chromatograph, Liquid Autosampler
	2	TOC Analyzer, Liquid Autosampler
	1	Autotitrator w/, Liquid & Solid Autosampler
	2	Spectrophotometers
	1	Turbidity Meter
	1	pH Meter
	1	Conductivity Meter
	2	Dissolved Oxygen Meters
	1	ISE Meter
Organic Extractions/Geotesting	6	Gel Permeation Chromatographs
	13	Hydraulic Conductivity Panels
	1	pH Meter