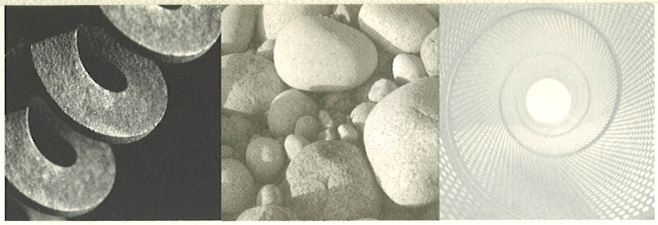
Appendix C PDI Work Plan, Supplemental PDI Work Plan, and NYSDEC Approvals



GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

Field Sampling Plan

Greenpoint Energy Center

Brooklyn, New York
Site No.: 224052

Submitted to:
National Grid
287 Maspeth Avenue
Brooklyn, NY 11201

Submitted by:
GEI Consultants, Inc.
One Greenwood Avenue, Suite 210
Montclair, New Jersey
973-509-9650

January 2009
Project # 081200

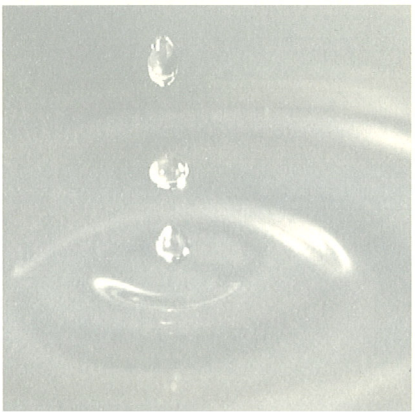


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Appendices

A Daily Activity Report
B Visual-Manual Description Standards
C Monitoring Well Information
D Chain of Custody
E Waste Tracking Form

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Abbreviations and Acronyms

APWA	American Public WorksAssociation
ASTM	American Society for Testing and Materials
COC	Chain Of Custody
CSOs	Combined Storm Sewer Outfalls
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
ELAP	Environmental Laboratory Approval Program
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FSP	Field Sampling Plan
GEI	GEI Consultants, Inc.
GPS	Global Positioning System
HASP	Health and Safety Plan
HDPE	High Density Polyethylene
HVAC	Heating, Ventilation and Airconditioning
IDW	Investigation-Derived Waste
LEL	Lower Explosive Limit
LNAPL	Light Non-Aqueous Phase Liquid
MGP	Manufactured Gas Plant
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NAPL	Non-Aqueous Phase Liquid
NTU	Nephelometric Turbidity Units
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PDA	Personal Data Assistant
PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protection Equipment
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SOP	Standard Operating Procedures
SVOC	Semivolatile Organic Compound
USDOT	United States Department of Transportation
VOC	Volatile Organic Compound

Abbreviations and Acronyms (cont.)

MEASUREMENTS

ft	feet
gal/ft^3	Gallons per cubic feet
ID	Inner Diameter
mL	milliliters
V	volume

1. Purpose

1.1 Introduction

GEI Consultants, Inc. (GEI) has prepared this Field Sampling Plan (FSP) to address the Pre-Design Investigation of the Greenpoint Energy Center site located at 287 Maspeth Avenue, in the Greenpoint neighborhood of Brooklyn, New York. The FSP is a companion document to the approved *Pre-Design Investigation Work Plan* (Work Plan), and the *approved Quality Assurance Project Plant (QAPP).* The FSP is broad in scope and is intended for use with future investigations at the Greenpoint Energy Center Site. The project location is shown on Figure 1 of the Work Plan. Proposed sample locations are summarized on Figure 2 of the Work Plan. The FSP was prepared to provide the applicable procedures for field investigation activities and remedial actions at the Greenpoint Energy Center.

2. General Field Procedures

2.1 Utility Clearance Procedure

Underground utilities, including electric, telephone, cable television, sewers, water, natural gas, etc., will be identified by owners/operators prior to any intrusive activity. The contractor/consultant will visit the site, mark out, and label by name every area where intrusive activity may occur with white paint, flags, or stakes. National Grid will provide underground utility locations on National Grid property, if necessary. The contractor will place a call to the New York City/Long Island One Call Center (1-800-272-4480) at least two, but not more than 10 days, prior to the commencement of work activities. The New York City and Long Island One Call Center is open 24 hours a day, 7 days a week. The drilling and excavation contractors will make note of ticket reference number and names of the utility operators that will be notified by the New York City and Long Island One Call Center. Public and privately owned utilities will be located by responsible agencies at least 48 hours prior to field activities. The contractor will check that each notified operator has either marked the work site or given an "all clear" prior to commencing work. Other potential on-site hazards such as sharp objects, known subsurface structures, overhead power lines, and building hazards will be identified during the site reconnaissance visit.

The American Public Works Association (APWA) Uniform Color Code For Marking Underground Utility Lines is as follows:

1. White – Proposed Excavation
2. Pink – Temporary Survey Markings
3. Red – Electric Power Lines, Cables, Conduit & Lighting Cables
4. Yellow – Gas, Oil, Steam, Petroleum & Gaseous Material
5. Orange – Communications, Alarm, Signal Lines, Cables or Conduit
6. Blue – Water
7. Purple – Radioactive Materials
8. Green – Sewers & Drain Lines

If intrusive activity occurs on private property, then a private mark out company will be contracted to identify any subsurface utilities or obstructions prior to sample collection. As a precaution, the first 5 feet or 1 foot below the nearest identified utility of the boring location will be cleared utilizing hand tools, vacuum excavation, or non-intrusive methods.

After the utility markouts are completed, care will be taken to prevent markouts from being covered, worn, or faded. If the markout paint becomes faded, the markout will be repainted using the uniform color code. If markouts have faded or have been compromised to the point where proper and safe excavation is no longer possible, the New York City/Long Island One Call Center (1-800-272-4480) and/or private utility markout service will be contacted and a request will be made for a new markout ticket.

References

1. Field Sampling Plan For Site Investigations At Manufactured Gas Plants, KeySpan, March 2004.
2. New York City One Call Center & Long Island internet web page online http://www.nycli1calldsi.com accessed on March 5, 2007.

2.2 Field Notebook Procedure

Objective

The field notebook is intended to serve as a record of significant field activities performed or observed during the project. The field notebook will serve as a factual basis for preparing field observation reports, if required, and reports to clients and regulatory agencies.

Procedure

1. Use a separate all-weather bound notebook for each site/location/project number.
2. Write neatly using black or blue waterproof pen (or note if field conditions [i.e., cold or wet weather] require use of pencil).
3. Write the project name, project number, and book number (i.e., 1 of 3) on the front cover. On the inside cover, identify the project name, project number, and "Return Book To:" the office address of the Project Manager (PM).
4. Number all of the pages of the field book starting with the first entry.
5. Record activities as they occur.
6. Neatly cross out mistakes using a single line and initial them. Erasures are not permitted. If an error is made on an accountable document assigned to one individual, that individual will make all corrections. The person who made the entry will correct any subsequent error discovered on an accountable document. All subsequent corrections will be initialed and dated.
7. Sign or initial and date the bottom of every page with an entry. Cross out unused portions of a page.
8. Record the following information upon each arrival at the site:
    a. Date/time/weather/project number
    b. Consultant personnel
    c. Purpose of visit/daily objectives

9. Record conversations with: [Recommendation - If possible, record telephone numbers of individual contacts for the site in the field notebook.]
    a. Contractors
    b. Clients
    c. Visitors (include complete names, titles, and affiliations whenever possible)
    d. Consultant office staff
    e. Landowners (site or abutters)
    f. Note time of arrival and departure of individuals visiting the site
10. Examples of the field information to be recorded, including time of occurrences:
    a. General site work activities
    b. Subcontractor progress
    c. Type and quantity of monitoring well construction materials used
    d. Use of field data sheets or electronic logging equipment (i.e., boring logs, monitoring well sampling logs, etc.)
    e. Ambient air monitoring data
    f. Locations and descriptions of sampling points
    g. Sample media (soil, sediment, groundwater, etc.)
    h. Sample collection method
    i. Number and volume of sample(s) collected and sample bottle preservatives used
    j. Sample identification number(s) and date and time of sample collection
    k. Approximate volume of groundwater removed before sampling
    l. Field observations
    m. Any field observations made such as pH, temperature, turbidity, conductivity, water level, etc.
    n. References for all maps and photographs of the sampling site(s)
    o. Information pertaining to sample documentation such as bottle lot numbers, dates and method of sample shipments, chain-of custody record numbers, and overnight shipping air bill numbers
    p. Surveying data (including sketches with north arrows)
    q. Changes in weather
    r. Rationale for critical field decisions
    s. Recommendations made to the client representative and PM
11. Record the following information upon departure:
    a. Include a site sketch or representative site photograph of conditions at the end of the day, if required
    b. Time
    c. Summarize work completed/work remaining
    d. Place a diagonal line though and sign portions of pages not used or skipped

Precautions

- Only record facts
- Do not fail to record an observation because it does not appear to be relevant at that time
- Identify conditions or events that could affect/impede your ability to observe conditions
- Do not use spiral notebooks because pages can be easily removed

References

1. *ASFE Model Daily Field Report* (1991), ASFE, Inc.
2. Field Sampling Plan For Site Investigations At Manufactured Gas Plants, KeySpan, March 2004.

2.3 Daily Activity Report Procedure

Objective

A daily activity report will be generated daily from the field database or field notebook to summarize the activities, observations, and decisions made during the day's fieldwork.

Procedure

At the completion of the day's fieldwork, all pertinent field observations will be recorded in the site database, computer electronic form, or on a hard copy paper form. If the electronic database is used, the database will generate the daily activity report that includes all samples collected and submitted to the laboratory for analysis. A daily activity report form is located in Appendix A. This report must be completed at the end of the workday. A draft daily activity report will be forwarded to the PM and site manager once completed. Field reports will be maintained at the site electronically and/or in hard copy form.

Contents of the report should include, at a minimum, the following information:

1. Date, project name, project number/phase/task, and site location.
2. A record of person(s) present at the site during the workday.
3. A brief description of the daily activities performed (e.g., drilled five borings in the overburden).
4. A summary of any significant field observations to including:
    a. A summary of deviation(s) from the work plan or objectives.
    b. A summary of field decision(s) made, who made it/them, and the basis for such decision(s).
    c. Any recommendations that may result from field observations and any actions that resulted from those recommendations.

5. A summary of specific fieldwork completed and site sketch (e.g. GPE-SB-01, drilled depth 20 feet).

Precautions

- The daily activity report should be based solely upon information. Any speculation should be clearly noted in the report as such.
- The daily activity report should never be released to anyone other than the PM or client unless explicitly authorized by the PM or client.

2.4 Field Boring Data Logging

Objective

To prepare and record a succinct, accurate representation of subsurface conditions, drilling and soil sampling activities, monitoring well installation details, and borehole abandonment procedures. A completed boring log should contain sufficient information to facilitate the preparation of geologic cross sections, to identify possible contaminant sources or pathways observed, and to offer readers a thorough account of drilling and borehole abandonment procedures.

Procedures

1. All borings will be recorded in a field notebook and/or electronically on a Personal Data Assistant (PDA) utilizing pLog™ or a similar soil logging program. Prior to beginning drilling activities, generic project header information, project staff, subcontractors, and anticipated geologic formations should be entered into the pLog™ database and downloaded to the PDA. If a field notebook is used, then logging will be completed in accordance with procedures described above in subsection 2.2.
2. Complete the log concurrently with drilling procedures (i.e., do not let the driller work faster than your ability to accurately represent the subsurface conditions).
3. If applicable, record the conventional geotechnical parameters during Standard Penetration Testing as per American Society for Testing and Materials (ASTM)-D1586, including blow counts of the hammer per 6-inch increment, total penetration of the split-spoon sampler, and length of the entire sample recovered. Record the weight of the hammer, size of the split-spoon sampler, and distance of the hammer fall.
4. Record the depth at which casing, augers, or drilling equipment are seated and the sizes of the equipment. Be certain to include sizes and seating depths of telescoped casing (if used).
5. Record the time at which each sample is retrieved from the borehole.
6. Record the results of any headspace tests performed on samples collected from discrete depths and also the type of field equipment used.

7. Provide soil descriptions in accordance with soil description procedures located below in Section 5.
8. Use the field book to record any relevant drilling observations that cannot be recorded on the PDA such as advance rate, water levels, drilling difficulties, changes in drilling method or equipment, amounts and types of any drilling fluids, running sands, and borehole stability.
9. Record the procedures and material used to abandon or seal each borehole upon completion.
10. At the completion of the day's activities, download the PDA to the database and generate, review, and edit (if necessary) the completed boring log. If a field notebook is used, make photocopies of the field notebook at the end of each day.

Precautions

- Electronic files should be backed up daily to prevent loss of data. A hardcopy of the boring logs for work performed each day should be generated as a backup. Hardcopy documents should be backed up also.
- Keep boring logs and rock core logs focused on actual observations. Record only factual information on the logs.

3. Surface Soil Sample Collection Procedure

The following surface soil sample collection procedure is applicable to the collection of representative surface soil. Alternative methods may be used at the field representative's discretion with the authorization of National Grid and New York State Department of Environmental Conservation (NYSDEC).

Procedure

1. Surface soil samples will be collected at the locations indicated in the Site Work Plan. Sample management is detailed in the QAPP.
2. Samples will be collected using decontaminated stainless steel equipment.
3. If the selected sampling location is in a vegetated area, the vegetation will be removed over a 1 square foot area prior to sample collection. The sample will be collected from within the top two (2) inches of the exposed ground surface.
4. Samples will be collected by digging into the soil with a pre-cleaned stainless steel trowel.
5. All samples selected for laboratory analysis will be placed in the appropriate containers provided by the laboratory. Sample containers for volatile organic analysis will be filled first. Next, a sufficient amount of the remaining soil will be homogenized by mixing the sample in a decontaminated stainless steel bowl with a decontaminated steel trowel or disposable scoop. This composite sample will be analyzed for all remaining parameters identified in the Site Work Plan.
6. All samples collected for analysis will be placed immediately into laboratory sample jars and properly stored in a cooler with ice to 4^{o}C before transport to the laboratory.
7. Duplicate samples will be collected at the frequency detailed in the QAPP by alternately filling two sets of sample containers. Composite samples may be required to obtain a sufficient soil volume.
8. Procedures for geologic logging, sample collection, and field classification are presented in Section 5. In addition, the surface soil sample will be described including:

    - Site;
    - Location number;
    - Interval sampled;
    - Date;
    - Initials of sampling personnel;
    - Soil type;
    - Color;

- Moisture content;
- Texture;
- Grain size and shape;
- Relative density;
- Consistency;
- Visible evidence of residues; and
- Miscellaneous observations (including organic vapor readings).

4. Subsurface Soil Sample Collection Procedure

The following subsurface soil sample collection procedure is applicable to the collection of representative subsurface soil using direct push Geoprobe® drilling, hollow-stem auger drilling, mud rotary drilling, or cased boring drilling methods. Alternative methods may be used at the field representative's discretion with authorization by the project manager and National Grid.

4.1 Sampling Methods

Location, equipment, and sampling situations will dictate the applicable method of sample collection for each boring location. Borings will generally be accomplished through the use of one of the following samplers or techniques:

- Geoprobe® Drilling Methods
- Hollow-Stem Auger Drilling Methods
- Mud Rotary Drilling Methods
- Cased Boring Drilling Methods
- Cone Penetrometer Methods
- Resonant Sonic Drilling Methods

These samplers and sampling techniques will result in the collection of representative samples.

4.2 Sample Interferences

Proper sampling procedures will be used to collect samples in accordance with Standard Operating Procedures (SOP) to prevent cross contamination and improper sample collection. Common causes of sample interferences are listed below to ensure that the samplers can avoid potential sample collection problems.

1. Cross Contamination. Eliminated or minimized through the use of dedicated or disposable sampling equipment where appropriate. Where the use of dedicated or disposable sampling equipment is not possible or practical, the equipment will be decontaminated in accordance with Section 12 – Equipment Decontamination Procedure.

2. Improper Sample Collection. Typical improper sample collection techniques include:

    - Improper decontamination of sampling equipment

- Use of sampling equipment or sample containers that are not compatible with the contaminants of concern.
- Sample collection in an obviously disturbed or non-representative area.

4.3 Equipment/Apparatus

Equipment needed for collection of subsurface soil samples may include (depending on technique chosen):

- Geoprobe® sampling apparatus
- 2-foot split spoon sampler
- Shelby tubes
- Stainless steel sampling tools
- Drilling contractor provided sample jars
- Drilling wax
- Shelby tube end-caps
- Electrical tape
- Clean sand
- Resealable plastic bags
- Decontamination equipment/supplies
- 5-gallon containers
- Photoionization Detector (PID)
- Pocket Penetrometer
- Torvane
- Water level indicator
- Ice
- Coolers and packing material
- Maps/plot plan
- Safety equipment
- Tape measure
- Digital camera
- Field data sheets/logbook/waterproof pen
- Permanent markers
- Paper towels
- Personal Protection Equipment (PPE)

4.4 Subsurface Soil Sample Procedure

Subsurface sampling will be conducted in accordance with the following general procedures and specific guidance for the methods discussed below.

4.4.1 General Procedures

Prior to sampling, New York City and Long Island One Call will be contacted and an accurate utility mark out will be established as described in subsection 2.1. If drilling on private property, then a private mark out company may be contracted to identify any subsurface utilities or obstructions prior to sample collection.

Prior to drilling the drilling rig will be inspected to make sure it is clean and that the down-hole equipment has been steam-cleaned. The steam cleaner will also be checked to ensure it is functioning properly (i.e., that steam is being produced). All lengths of downhole equipment including drilling rods, bits, and attachments will be measured and recorded in the field notebook.

At each location, plastic sheet, plywood sheet, or other suitable cover will be placed around the borehole during drilling to contain soil cuttings.

Procedures for geologic logging, sample collection, and field classification are presented in Section 5.

If a boring exhibits the presence of Non-Aqueous Phase Liquid (NAPL), drilling will proceed until signs of the free and residual product are no longer visible in accordance with the work plan and the limitations of the drilling equipment. Any deep drilling through nearby impacted zones will ensure that there is no vertical communication caused by the drilling. Specifically, the upper impacted units may be cased and grouted into a lower, more confining unit, if encountered.

All the borings will be backfilled using a tremie pipe from the bottom to the top of the bore hole with cement/bentonite grout in accordance with NYSDEC guidelines for standard grout mixtures:

- One 94-pound bag Type I Portland cement
- 3.9 pounds powdered bentonite
- 7.8 gallons potable water

The boring will be grouted to the surface and allowed to cure overnight. If excessive settling is observed in the borehole due to seepage of the grout into the formation, then additional grout may be applied. The surface conditions including any asphalt/concrete surface will then be restored to its original condition.

Investigation derived wastes will be handled as specified in the investigation-derived waste handling procedure located in Section 14.

4.4.2 Direct Push Geoprobe® Procedures

For direct push Geoprobe® methods, discrete soil samples will be collected from each boring using a 4-foot or 5-foot close piston Macro-Core® sampler configuration. Macro-Core® will be advanced to the beginning of the intended sample interval, the piston will be released and remain in place, and the Marco-Cores® will be driven to the end the intended sample interval. This method will ensure that sampling of "slough" does not occur. The Macro-Core® will then be retrieved and the collected soil core will be extruded from the sampler along with the liner. Because the Macro-Core® sampling tube uses a dedicated, disposable liner made of clear plastic, the only part of the sampler that contacts the soil sample is the cutting shoe. Each sample liner will be disposed of after use and a new liner will be placed in the macro-core tube prior to collection of subsequent samples. Cutting shoes and sample collection spoons used to transfer samples to the laboratory jars will be decontaminated as indicated below in subsection 12.2.1 between use. After decontamination, the Macro-Core® sampler will be re-assembled using a new liner.

4.4.3 Hollow Stem Auger Procedures

For hollow-stem auger methods, split-spoon sampling will be conducted in accordance with ASTM Specification D-1586-84 for standard penetration test and split barrel sampling. Soil samples will be collected continuously through split-spoon sampling methods at the boring location. Split-spoon samples will be collected ahead of the lead auger flight.

Upon collection of each split-spoon sample, the lead auger will be advanced over the sampled interval prior to collection of the next split-spoon sample. This method will ensure that the borehole is cased to the depth of the next sample. In addition, while the augers are being advanced a temporary auger plug will be placed at the bottom of the lead auger to minimize or eliminate the potential for formation materials to run up into the augers. The use of an auger plug will help assure that split-spoon samples are representative of *in-situ* formation materials. Split-spoons will be decontaminated after each sample is collected as indicated below in subsection 12.2.1.

Limitations
In areas of significant soil contamination, hollow-stem augers may cross-contaminate upper soil layers as contaminated cuttings move up the auger flights. The potential also exists for contaminated augers to carry contamination to deeper soil strata. When drilling below the groundwater table in fine to medium sands, the potential exists for the phenomenon of "running sands" or "blow in" to occur. Frequent measurements inside the hollow-stem augers after the drill bit/plug is removed will indicate if running sands are present. If sands start to flow into the auger, pour clean water into the augers and keep the augers filled during sampling.

4.4.4 Rotary Procedures

For mud rotary methods, split-spoon sampling will be conducted in accordance with ASTM Specification D-1586-84 for standard penetration test and split barrel sampling. Steel casing will be driven to a depth that will adequately prevent surficial erosion of the borehole. Drilling mud shall be viscous enough to prevent the borehole from collapsing across all strata and depths. Changes in the soil cuttings discharged in the drilling mud, drilling mud loss, and the addition of new drilling mud will be noted in the field book. Soil samples will be collected continuously through fill and at 5-foot intervals, thereafter, via split-spoon sampling methods at the boring location. Upon collection of each split spoon sample, the borehole cleaned out by circulating the drilling mud and advancing the roller bit to the next sample's proposed depth. If a NAPL is encountered, new drilling mud will be circulated until it is no longer visually impacted and, if needed, thickened to prevent infiltration of NAPL into the borehole. Split-spoons will be decontaminated after each sample is collected as indicated below in subsection 12.2.1.

4.4.5 Cased Boring Procedures

For cased boring methods, split-spoon sampling will be conducted in accordance with ASTM Specification D-1586-84 for standard penetration test and split barrel sampling. Steel casing will be driven into the ground using a 300 pound hammer. Casing will be driven to the depth of sample collection. Changes in the soil cuttings discharged in the drilling fluid, drilling fluid loss, and the addition of drilling fluid will be noted in the field book. Soil samples will be collected continuously through fill and at 5-foot intervals thereafter via split-spoon sampling methods at the boring location. Upon collection of each split-spoon sample, the casing will be advanced to the next sample collection depth and washed out by using the roller bit and drilling fluid prior to collection of the next split-spoon sample. Split-spoons will be decontaminated after each sample is collected as indicated below in subsection 12.2.1.

4.5 Shelby Tube Sampling

Shelby tube samples will be collected in accordance with the latest revision of ASTM D/587. When the desired sampling depth is reached, the borehole casing will be cleaned out using the roller bit. The Shelby tube will be lowered to the bottom of the borehole, then advanced (pushed) via pressure without rotation by a continuous relatively rapid motion until 24 inches of penetration is achieved. At the discretion of the field geologist, a period of approximately 10 minutes, measured from the time of insertion, will be allowed to provide for the sample to expand and adhere to the tube walls. Prior to removal, the tube may be rotated two complete revolutions to shear the bottom of the sample from the native material.

Upon removal, the field geologist will log the tops and bottoms of the sample for soil classification and perform applicable field tests. Samples recovered via Shelby tube will be

preserved in conformance with the latest revision of ASTM D 4220. To preserve the natural moisture content of the samples, the tube ends will be sealed with a minimum of 0.50 inch of paraffin wax. Plastic slip caps will be applied at the ends of the sample tube, taped, then dipped and sealed in wax.

References

1. New York State Department of Environmental Conservation, Division of Environmental Remediation, 2003. *Groundwater Monitoring Well Decommissioning Procedures*. NYSDEC, April, 2003.

2. ASTM, 1997. D1586-84 (1992) Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils. ASTM, West Conshohocken, PA. 1997.

3. ASTM D6001-05 Guide for Direct Push Water Sampling for Geoenvironmental Investigations, April 2005

5. Soil Description Procedure

The following soil description procedure is applicable for use in describing surface and subsurface soils. This procedure may be varied or changed as required, dependent upon site conditions and equipment limitations. Any deviation from this standard will be documented in the field-sampling book and in the final report.

5.1 Description Method

All soils will be described using the Unified Soil Classification System/ASTM D2488. The use of one standard will allow continuity of sampling descriptions between sample locations and personnel.

5.2 Sample Interferences

Proper handling of cores while recording descriptions will be used to ensure that handling does not affect sample collection or cause cross contamination within the core sample.

Cross contamination will be eliminated or minimized with dedicated or disposable sampling equipment where appropriate. Where the use of dedicated or disposable sampling equipment is not possible or practical, the equipment will be decontaminated in accordance with the procedure for the decontamination of field sampling equipment located below in Section 12.

5.3 Equipment/Apparatus

Equipment needed for description of soil samples may include:

- Stainless steel sampling tools
- Decontamination equipment/supplies
- Safety equipment
- Tape measure
- Camera
- Field data sheets/field notebook/waterproof pen
- Permanent marker
- PPE

5.4 Soil Sample Description Procedure

The sampling procedure is as follows:

All soils are to be logged using ASTM D2488 *Standard Practice for Description and*

Identification of Soils. The description of each sample interval should be prepared as follows:

1. The specific intervals for description should be noted for each sample. The description should not necessarily be for the entire subsurface soil interval. Geologic horizons, small-scale units, or other changes in soil conditions within the subsurface soil sample should be identified and described separately.
2. Soil description should include particular notes if the field representative believes that there is a possibility the soil sample being described is not representative of the interval sampled.
3. The following data will be recorded on the sample collection method, if applicable:
    a. Method of collection, hollow stem auger, rotosonic, Geoprobe®, etc.
    b. Interval sampled vs. amount recovered.
    c. Blow counts, weight of hammer, and hammer free fall distance for split spoon samplers, if used.
4. For course grained soils with less than 50% fines:
    a. GROUP NAME (SYMBOL), Structure, % Gravel Sand and Fines in order of predominance, % Cobbles and/or boulders (by Volume), Maximum Particle Size, Other (moisture, depositional descriptions, representativeness), Color, Local or Geologic Name, environmental/geologic descriptions.
5. For fine grained soils with greater than or equal to 50% fines:
    a. GROUP NAME (SYMBOL), Structure, Plasticity, Plasticity characteristics (if performed), % Gravel Sand, and size ranges, Other (moisture, depositional descriptions, representative nature), Color, Local, or Geologic Name, Field Soil Strength measurements (if performed), environmental/geologic descriptions.
6. Specific descriptions of each of the above description categories are described in Appendix B or below.
7. Soil moisture will be described as Dry, Moist, or Wet.
8. Soil color will be described using the color chart in Appendix B. Colors may be combined: e.g., red-brown. Color terms should be used to describe the "natural color" of the sample as opposed to staining caused by contamination.
9. The representative nature of the sample interval should be noted if there is a possibility the soil sample being described is not representative of the interval sampled.
10. Visual evidence of contamination should be described in the sample log with the specific depths or depth intervals where the contamination was noted. Descriptions of visual, olfactory, and product observed should conform to the following standards.

a. **Sheen** - iridescent petroleum-like sheen. Not to be used to describe a "bacterial sheen" this can be distinguished by its tendency to break up on the water surface at angles, whereas petroleum sheen will be continuous and will not break up. A field test for sheen is to put a soil sample in a jar of water and shake the sample (jar shake test), then observe the presence/absence of sheen on the surface of the water in the jar.
b. **Stained** - used w/color (i.e., black or brown stained) to indicate that the soil matrix is stained a color other than the natural (non-impacted) color of the soil.
c. **Coated** - soil grains are coated with tar/free product – there is not sufficient free-phase material present to saturate the pore spaces.
d. **Blebs** - observed discrete sphericals of tar/free product - but for the most part the soil matrix was not visibly contaminated or saturated. Typically, this is residual product.
e. **Saturated** - the entirety of the pore space for a sample is saturated with the tar/free product. Care should be taken to ensure that you are not observing water saturating the pore spaces if you use this term. Depending on viscosity, tar/free-phase saturated materials may freely drain from a soil sample.
f. **Oil**. Used to characterize free and/or residual product that exhibits a distinct fuel oil or diesel fuel like odor distinctly different from manufactured gas plant (MGP)-related odors/impacts.
g. **Tar**. Used to describe free and/or residual product that exhibits a distinct "coal tar" type odor (e.g., naphthalene-like odor). Colors of product can be brown, black, reddish-brown, or gold.
h. **Solid Tar**. Used to describe product that is solid or semi-solid phase. The magnitude of the observed solid tar should be described (e.g. discrete granules or a solid layer).
i. **Purifier Material**. Purifier material is commonly brown/rust or blue/green wood chips or granular material. It is typically associated with a distinctive sulfur-like odor. Other colors may be present.
j. **Olfactory Descriptors.** Use terms such as " tar-like odor" or "naphthalene-like odor" or "fuel oil-like odor" that provide a qualitative description (opinion) as to the possible source of the odor. Use modifiers such as strong, moderate, faint to indicate intensity of the observed odor.
k. **Dense Non-Aqueous Phase Liquid (DNAPL)/Light Non-Aqueous Phase Liquid (LNAPL).** A jar shake test should be performed to identify and determine whether observed tar/free-phase product is either denser or lighter than water. In addition, manufactured gas plant (MGP) residues can include both light and dense phases - this test can help determine if both light and dense phase materials are present at a particular location.
l. **Viscosity of Free-Phase Product** – If free-phase product/tar is present, a qualitative description of viscosity should be made. Descriptors such as:

Highly viscous (e.g. taffy-like)
Viscous (e.g. No. 6 fuel oil or bunker crude like)
Low viscosity (e.g. No. 2 fuel oil like)

11. A PID or flame ionization detector (PID/FID) will be used to screen all soil samples at the core location at 6- to 12-inch intervals. This screening data may be used to aid in selection of specific analytical sampling intervals. In addition, the PID or FID will be used to screen samples using the jar headspace method described below in subsection 5.5. The maximum readings from the jar headspace screening will be recorded and included on the logs. PID or FID will be calibrated daily at a minimum.

5.4.1 Fine Grained Soil Field Tests

Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

5.4.1.1 Dry Strength:

From the specimen, select enough material to mold into a ball about 1 inch in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

From the molded material, make at least three test specimens. A test specimen shall be a ball of material about 1⁄2 inches in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 140° Fahrenheit.

If the test specimen contains natural dry lumps, those that are about 1⁄2 inches in diameter may be used in place of the molded balls. It is important to note process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accordance with the criteria in below:

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

If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid.

5.4.1.2 Dilatancy

From the specimen, select enough material to mold into a ball about 1/2 inch in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria below.

- **None** - No visible change in the specimen
- **Slow** - Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
- **Rapid** - Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

The reaction is the speed with which water appears while shaking, and disappears while squeezing.

5.4.1.3 Toughness & Plasticity

Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about 1/8 inch in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation). Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

Describe the toughness and plasticity of the thread and lump as low, medium, or high in accordance with the criteria below:

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

5.4.1.4 Pocket Penetrometer Penetration Testing

1. Choose your test location with care to avoid gravel or other particles that would influence reading. Avoid obviously disturbed areas. For saturated cohesive soils, it is important that readings be taken in "fresh" samples or cut surfaces, since rapid drying will greatly influence the reading.
2. Return ring to back position against the penetrometer body, making sure the front edge is at the zero reading.
3. Grip the handle firmly, insert the shaft ¼" in depth with a smooth constant force into the soil mass or sample.
4. Take reading from the top of the indicator ring.
5. Clean soil off penetrometer with a damp soft cloth.

5.4.1.5 Torvane Testing

1. Choose your test location with care to avoid gravel or other particles that would influence reading. Avoid obviously disturbed areas. For saturated cohesive soils, it is important that readings be taken in "fresh" samples or cut surfaces, since rapid drying will greatly influence the reading.
2. Return dial to back position against the torvane body, making sure the front edge is at the zero reading.
3. Grip the handle firmly, turn torvane with a smooth constant force into the soil mass or sample.
4. Take reading from the dial. Be sure to note which vane size is used as a conversion factor may be needed.
5. Clean soil off torvane with a damp soft cloth.

5.5 Soil Screening Procedure

The objective of field screening of soils is to measure the relative concentrations of Volatile Organic Compounds (VOCs) present in soil at the project site. This information can be used to: 1) segregate soil based upon the degree of impacts, 2) to identify samples for laboratory analysis of VOCs, and 3) as a qualitative method to evaluate the presence or absence of VOCs in soils. A PID or FID may be used.

Procedure

1. Prior to sampling event, the instrument must be calibrated in accordance with the manufacture's specification. Record the type of calibration gas, detector, and lamp in the field notebook.
2. Record background readings of atmospheric conditions in the work area while walking across the work area. The highest meter response should be recorded in the field notebook.
3. Fill a clean, glass jar approximately half way with soil. Use a clean stainless steel sampling implement. Quickly cover the open top with one or two sheets of clean, aluminum foil and screw on the cap to tightly seal the jar. Label the sample location and depth from which the sample was collected on the jar.
4. Allow headspace development for at least 10 minutes at an ambient temperature of 50°F or greater. Vigorously shake the jar for 15 seconds at the beginning and end of the headspace development period. When ambient temperatures are below 50°F, place the jar in a heated vehicle or building during the headspace development period.
5. After headspace development, gently remove the screw cap and expose the foil seal. Quickly puncture the foil seal with the instruments tip to approximately ½ of the headspace depth.
6. Following the probe insertion through the foil seal, record the highest meter response as the jar headspace concentration. Maximum response should occur within 3 to 5 seconds after probe insertion.

Precautions

- Follow safety procedures defined within the Greenpoint Energy Center Site Health and Safety Plan (HASP).
- The various instruments may work poorly in rain, high humidity, or in cold temperatures. In these instances, headspace readings will be completed in dry or warm areas.
- Care must be taken to prevent water or soil particulates from entering the tip of the instrument. If this occurs, the probe tip should be cleaned before further use.
- While establishing background conditions and performing jar headspace screening, care should be taken to avoid extraneous VOC sources such as vehicle emissions or other organic vapor sources.

5.6 Air Monitoring Procedure

Air monitoring will be conducted as specified in the Work Plan and the HASP dated June 2008 that is provided as part of the Work Plan. Air monitoring will be conducted utilizing a PID during all intrusive subsurface soil-sampling activities. A multiple gas meter will be used to monitor will be used to monitor for total VOCs, hydrogen cyanide, hydrogen sulfide,

Lower Explosive Limit (LEL), and percent oxygen during intrusive subsurface soil sampling activities. During subsurface soil sampling, particulate monitoring will be conducted with a personal mini-ram digital particulate meter up wind and downwind of the work zone. All monitoring equipment will be calibrated at the beginning of the day and more frequently, if needed, with manufacturer specified calibration gas.

5.7 Quality Assurance/Quality Control (QA/QC)

There are no specific QA activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

- All data must be documented on field data sheets or within site logbooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/ operation and they must be documented.

5.8 Soil Sample Handling and Labeling Procedure

All soil samples collected via Shelby tubes will be stored upright at all times at temperatures above freezing. Care will be taken during transport of the samples to minimize vibration. Each Shelby tube sample will be labeled with the following information: 1) Project Name, 2) Project Number, 3) Boring Number, 4) Sample Number, 5) Sample Depth Interval, 6) Top and Bottom, and 7) Date.

Representative soil samples collected from Geoprobe or split-spoon samplers will be placed in an 8 ounce jar and/or resealable plastic bag. At least one grab sample from each strata encountered over the sample interval (i.e., Geoprobe sample interval or split-spoon sample interval) will be retained for archival and/or geotechnical analysis. Each sample jar or jar lid will be labeled with the following information: 1) Boring Number, 2) Sample Number, 3) Sample Depth Interval, 4) Recovery, and 5) Blow Counts (if SPT). Each box containing the soil samples will be labeled with the following information: 1) Project Name, 2) Project Number, 3) Borehole Number, 4) Depth Range, 5) Date(s), and 6) Logging Geologist/ Engineer.

All analytical samples collected will be labeled in accordance with the table listed below.

PRIMARY SAMPLES TYPES	QA/QC SAMPLE TYPES
SOIL SAMPLES	**FIELD BLANKS**
Surface Soil- Number (SAMPLE DEPTH-FEET)	SAMPLE-[DATE]
GPE-SS-01 (0-0.2)	GPE-SS-FB-033108
Test Pit-Number (SAMPLE DEPTH-FEET)	GPE-SB-FB-033108
GPE-TP-01 (5-6)	GPE-SED-FB-033108
Direct Push Boring- Number (SAMPLE DEPTH-FEET)	GPE-MW-FB-033108
DP-01 (10-15)	

PRIMARY SAMPLES TYPES	QA/QC SAMPLE TYPES
Hand Auger- Number (SAMPLE DEPTH-FEET) GPE-HA-01 (10-15) Geotechnical Boring-Number (SAMPLE DEPTH-FEET) SB-01 (10-15) **SEDIMENT SAMPLES** Sediment Boring Number (SAMPLE DEPTH-FEET) GPE-SED-01 (0-5) **GROUNDWATER SAMPLES** Direct Push Monitoring Well- Number GPE-MW-01 Test Well/Sump- Number GPE-TW-03 **SEDIMENT SAMPLES** Sediment Core- Number GPE-SED-01	**MATRIX SPIKE/DUP** SAMPLE [Number] [DEPTH] [EITHER Matrix Spike (MS) OR Matrix Spike Duplicate (MSD)] GPE-SS-01 (0-2) MS GPE-SS-01 (0-2) MSD GPE-SB-01 (10-15) MS GPE-SB-01 (10-15) MSD GPE-SED-01 (15-20)MS GPE-SED-01 (15-20)MSD GPE-MW-01 MS GPE-MW-01 MSD **TRIP BLANKS** SAMPLE-[DATE] GPE-TB-063008 **BLIND DUPLICATES** SAMPLE - Number [XX][DATE] GPE-SS-XX-030309 GPE-SB-XX-030309 GPE-SED-XX-030309 GPE-TW-XX-030309

In addition to the information listed above, each sample will be labeled with the date and time the sample was collected, laboratory analysis requested, initials of the sampler(s), and the project number. Sample handling procedures are located in the QAPP.

References

1. ASTM *D 2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).* ASTM International, West Conshohocken, PA.

2. ASTM *D 2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).* ASTM International, West Conshohocken, PA.

6. Test Pit Excavation

The following test pit soil sample collection procedure is applicable to the collection of representative subsurface soil using a backhoe. Alternative methods may be used at the field representative's discretion with the authorization of National Grid and NYSDEC.

6.1 Test Pit Specifications

Test pits will be excavated and backfilled according to the following specifications:

a. When specified in Site Work Plan, test pits will be excavated using a rubber-tired backhoe. In the event deep excavations are required, a track hoe will be utilized.
b. Locations of test pits will be finalized in the field, based on the location of potential source areas and existing underground utilities.
c. If the prospective test pit location is covered by asphalt or concrete, the area will be saw cut prior to excavation.
d. During excavation activities, personnel will stand upwind of the excavation area to the extent possible. Air monitoring will be conducted in accordance with the HASP.
e. Test pit materials will be visually described, as well as photographed for future reference.
f. Material removed from the test pit will be placed on polyethylene sheeting.
g. Should sampling of excavated material be performed, samples will be collected from the stockpiled material and/or the backhoe bucket.
h. Upon completion, the materials from the test pit will be placed back in the excavation in the reverse order in which it was excavated.
i. Visually clean soils, such as surface soils, will be segregated from soils that may be impacted. The visually clean soils will be used to cover the impacted soils/source materials when placed back in the excavation.
j. Test pits will be backfilled as soon as possible after completion. No test pit excavation will remain open overnight.
k. For gravel roadways and parking areas, the backfill will be tamped down in 18-inch lifts. A six (6) inch layer of clean run of crushed gravel will be tamped in-place as the final lift. For test pits located in asphalt-covered areas, the surface will be replaced with cold or hot asphalt mix, compacted by rolling, and trimmed flush with the adjoining surface. Test pits located in grassed areas will be reseeded.
l. Following restoration of the excavation, the test pit will be staked to facilitate subsequent location by surveying crews, if necessary.
m. If during test pit activities a pipe or other buried utility is encountered, excavation will cease, the orientation and dimensions will be recorded, the test pit backfilled

and a new test pit attempted in the general vicinity of the initial location. If a pipe or underground utility is accidentally severed, the owner of the utility, then National Grid, will immediately be notified. Liquid flows or electricity will be shut off immediately and appropriate repairs initiated as soon as possible. If a release of liquid occurs, the Consultant/Contractor PM will notify National Grid who will then notify NYSDEC. Appropriate response actions will be implemented.

Reference

1. Field Sampling Plan For Site Investigations At Manufactured Gas Plants, KeySpan, March 2004.

7. Monitoring Well Installation and Development

Monitoring wells will be installed at the completion of the soil boring installation. The following procedures will be used to install and develop all permanent monitoring wells.

7.1 Monitoring Well Specifications

Monitoring wells installed in unconsolidated deposits that do not penetrate a presumed confining layer will be constructed according to the following specifications:

1. Install Polyvinyl chloride (PVC) 1.5-inch inner diameter or 2-inch inner diameter, threaded, flush-joint casing, and 1.5-inch inner diameter pre-packed or 2-inch inner diameter screens.
2. Monitoring wells will be screened in the unconsolidated deposits. Screens will be 5 feet in length, and slot openings will be 0.010 inch. Alternatives may be used at the discretion of the field geologist, based on site-specific geologic conditions.
3. A sump of a least 1 inch will be attached to the bottom of the monitoring well screen. If DNAPLs are known or suspected to exist on site at elevations above the monitoring well screen, a sump of at least 24 inches in length will be attached to the bottom of the screen.
4. Where appropriate, the annulus around the screens will be backfilled with clean silica sand (based on site-specific geologic conditions and screen slot size). Clean silica sand will be extend from least 12 inches below the monitoring well screen to a minimum height of 24 inches above the top of the screen.
5. Where appropriate a bentonite pellet seal or bentonite slurry will be placed above the sand pack. If a pellet seal is used, it will be allowed to hydrate for at least 30 minutes before placement of grout above the seal. Where possible, the bentonite pellet seal will be a minimum of 24-inches in depth, except in those instances where the top of the monitoring well screen is in close proximity to the ground surface. In these instances, a bentonite seal of at least 12 inches in length will be placed above the monitoring well screen. If the bentonite seal is located above the water table at least 5 gallons of potable water will be used to hydrate the bentonite.
6. The remainder of the annular space will be filled with a cement grout up to the ground surface. The grout will be pumped from the bottom up. The grout will be mixed in the following relative proportions: One 94-pound bag Type I Portland cement, 3.9 pounds powdered bentonite, and 7.8 gallons potable water. The grout will be allowed to set for a minimum of 48 hours before monitoring wells are developed.

7. The protective surface casing will be either a flush-mounted roadbox or a steel "stick up" pipe. The base of either type of casing must extend at least 1 foot into the grout below the ground surface (below the frost line) whenever possible. The top of the casing will be finished using flush-mount casings with keyed-alike locks.
8. The monitoring well riser will be cut flat and a mark, "V"-notch, an arrow on the casing will be placed with an indelible marker at one point for surveying and groundwater measurements. The monitoring well riser will be cut so that the top of the monitoring well is 3 to 6 inches below the top of the protective casing.
9. The bentonite-cement grout in the annular space will be set between the protective casing and the borehole up to the ground surface. The concrete will be sloped radially away from the protective casing at the ground surface to promote surface water runoff. In areas of high traffic or areas of parking lots and/or roadways where plowing occurs, set the roadbox flush with the ground surface to avoid damage to the monitoring well.
10. A concrete surface pad (2 feet x 2 feet x 6 inches) will be sloped to channel water away from the monitoring well casing.
11. If the monitoring well is constructed with a protective standpipe, a weep hole will be drilled at the base of the protective standpipe casing to allow any water between the inner and outer casing to drain. If constructed in a high traffic area, standpipe maybe protected with a bollard.
12. The top of the PVC monitoring well casing will be marked and surveyed to 0.01 foot, and elevations will be determined relative to a fixed benchmark or datum. The measuring point on all monitoring wells will be on the innermost PVC casing.
13. Characteristics of each newly installed monitoring well will be recorded in the field notebook. A monitoring well checklist is shown on Figure 1 and a generic overburden monitoring well diagram is shown on Figure 2 attached within Appendix C.

Monitoring wells that penetrate a confining layer will be installed via double/isolation casing.

A typical double-cased monitoring well construction diagram for monitoring wells installed in unconsolidated soils that penetrate a presumed confining layer is located in Appendix C. The decision to install double-cased monitoring wells will be made on a boring-specific basis by the field geologist. Double-cased monitoring wells will be installed when the boring for the monitoring well penetrates a presumed confining layer. The confining layer shall be defined as a minimum five (5) foot thick, predominantly clay unit that has been shown to be laterally continuous across the site. In the event the field geologist, National Grid, and NYSDEC PMs decide a reasonable possibility exists for contamination to be deposited in

deeper, clean zones during the drilling and installation of a monitoring well, the monitoring well will be double-cased. The purpose of the steel protective casing will be to minimize the possibility that residual contamination is deposited at the depth of the screened interval during the drilling process.

Monitoring wells that penetrate confining layers will be installed according to the following specifications:

- 6-inch Inner Diameter (ID) steel outer casings will be installed to a depth of at least 2 feet below the lower limit of observed or measured contamination and/or the confining layer. This casing will be grouted in place with cement or sealed by alternate methods approved by the NYSDEC to inhibit downward migration of contamination.
- The 6-inch casing will be installed through 6.25-inch ID hollow-stem augers. The augers will be filled with grout prior to their removal to ensure the integrity of the borehole and the grout seal. Then, the 6-inch casing will be installed into the grout and hydraulically pushed approximately 1-foot beyond the bottom of the boring. Potable water will be tremied to the bottom of the inside of the casing to dilute the grout, thereby, allowing the grout to be more easily pumped out of the casing. The grout pumped out of the casing will be drummed and staged with other Investigation-Derived Waste (IDW). Alternate isolation methods may be used as approved by the NYSDEC.
- The cement-bentonite grout remaining in the annulus between the casing and the formation will be allowed to set for at least 24 hours before drilling is continued. The drilling will then continue using a 4-inch-diameter, flush-joint spin casing or other appropriately sized drill casing and potable water. All lubricant water will be containerized.

The monitoring well will be constructed of 2-inch-diameter PVC or stainless steel riser pipe and screen, sand pack, bentonite seal, grout, and surface casing as specified for single cased monitoring wells and in accordance with NYSDEC requirements. The bentonite seal may consist of pellets or a mixture of bentonite slurry and sealed with grout. The grout will be mixed in the following relative proportions: One 94-pound bag Type I Portland cement, 3.9 pounds powdered bentonite, and 7.8 gallons potable water. The grout will be allowed to set for a minimum of 48 hours before monitoring wells are developed.

7.2 Monitoring well Development

Monitoring wells will be developed to remove drilling fluids, to remove fine soil particles that may be trapped in the monitoring well's sand pack and screen, and to set the sand pack so that it will function properly. After a minimum of 48 hours after completion of permanent monitoring wells, the following procedure will be used in the monitoring well development:

1. All development equipment will be decontaminated prior to use with methanol, Alconox, and deionized-water rinses.
2. The volume of water in the monitoring well (one monitoring well volume) will be calculated and record volume on Monitoring Well Sampling Record (Appendix C).
3. A sample of water from the monitoring well will be collected with a submersible pump, a bailer, or a water pump. The color, turbidity, and organic vapor concentration (as measured by a PID) of the sample will be recorded. The greater of the following amounts of groundwater will be removed:
   i. Ten monitoring well volumes
   ii. The volume of fluid added during drilling
4. Groundwater will be purged until it runs clear (<50 nephelometric turbity units [NTUs]).
5. The purge rate (gallons per minute) and total volume purged will be recorded.
6. During development the groundwater level will be monitored to determine if the pumping rate is sufficient to create a drawdown in the monitoring well.
7. Groundwater samples will be collected every few monitoring well volumes during the pumping and record the physical properties (color and turbidity).
8. Pumping will be stopped when the purge water is relatively clear. A surge block will then be slowly moved up and down the water column in the monitoring well. The surge block will be periodically removed and groundwater will be purged until it is relatively clear again. Surging will start at a slow pace and progress to a faster.
9. Monitor the turbidity and color of the water during this procedure. The monitoring well is considered fully developed when all of the following criteria have been met:
10. The volume of fluid added during drilling has been removed.
11. The water removed from the monitoring well is relatively free of fine-grained particles.
12. Record the volume of water pumped from the monitoring well and the physical properties (color, turbidity) of the water.

Precautions

1. Always remove groundwater with fine particles from the monitoring well before surging. The fine particles may be forced into the monitoring well screen by the surging action.
2. Pump contaminated groundwater into a properly labeled drum.
3. Use a bailer to develop monitoring wells that are installed in soils that are composed of fine-grained silts and clays. Pumping and mechanical surging

is not recommended because these more vigorous techniques can cause fine particles to clog the filter pack.

4. Sampling of groundwater should not occur within two weeks after development.

Calculations

To calculate the volume of water in the monitoring well, the following equation is used:
Monitoring well Volume (V) = Br2 h (cf) **[Equation 1]**
where:

B = pi (3.14)
r = radius of monitoring well in feet (ft)
h = height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the monitoring well as measured from the same reference point.]
cf = conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3. [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitoring well diameters are typically 2-, 3-, 4-, or 6-inches. A number of standard conversion factors can be used to simplify the above equation using the diameter of the monitoring well. The volume, in gallons per linear foot, for various standard monitoring well diameters can be calculated as follows:

where:

V (gal/ft) = Br^2 (cf) **[Equation 1]**
B = pi (3.14)
r = radius of monitoring well (ft)
cf = conversion factor (7.48 gal/ft^3)

For example, a 2-inch-diameter monitoring well, the volume per linear foot can be calculated as follows:

V (gal/ft) = Br^2 (cf) **[Equation 2]**
= 3.14 (1/12 ft)2 7.48 gal/ft^3
= 0.1631 gal/ft

NOTE: The diameter must be converted to the radius in feet as follows:

Monitoring well Diameter (inches) x 0.5 = Monitoring well Radius (ft) **[Equation 3]**

The volume in gallons/feet for the common size monitoring wells are as follows:

Monitoring well diameter (inches)	Volume (gal/ft)
2	0.1631
3	0.3670
4	0.6524
6	1.4680

If you utilize the volumes for the common size monitoring wells above, Equation 1 is modified as follows:

where:

Monitoring well volume = (h) (f) **[Equation 4]**

h = height of water column (ft)

f = the volume in gal/ft calculated from Equation 2

7.3 *In-Situ* Hydraulic Conductivity Testing

In-situ hydraulic conductivity testing may be performed on selected monitoring wells as indicated in the Site Work Plan to obtain estimates of groundwater velocities and potential groundwater recovery rates for the aquifer. The objective of the hydrogeologic testing is to determine the hydraulic properties of the aquifer in the vicinity of the site.

Slug tests may be conducted in selected monitoring wells utilizing the rising or falling head slug test technique. Rising head tests can be performed in unconfined and confined aquifers. Falling head tests should only be performed in confined aquifers. The slug tests will be performed by subjecting water-bearing units in the screened interval to a stress caused by the sudden displacement of the water level within the monitoring well. The rising head tests will be conducted as follows:

1. Slugs and other downhole equipment will be decontaminated before and after each test by methods described in Section 12.
2. Prior to conducting each slug test, the static water level in the monitoring well will be measured to the nearest 0.01 foot. Water levels will be measured during the test with an electronic water level indicator and with pressure transducers attached to a data logger, thereby providing water level measurements by two independent devices.
3. A weighted slug of known volume will be inserted gently into the monitoring well below the water table. The water level will be measured until the water level returns to static conditions.
4. The slug will be suddenly withdrawn from the monitoring well and the water level recovery will be monitored at appropriate intervals until recovery is complete and stabilized.

5. Monitoring wells that were bailed dry during development may not be able to provide meaningful data through slug tests. Tests will be terminated in monitoring wells that do not recover significantly (>80% of static level) within one hour. These monitoring wells will be bailed dry and their recovery measured with an electronic water level indicator.

The falling head tests will be conducted as follows:

1. Slugs and other downhole equipment will be decontaminated before and after each test by methods described in Section 12.
2. Prior to conducting each slug test, the static water level in the monitoring well will be measured to the nearest 0.01 foot. Water levels will be measured during the test with an electronic water level indicator and with pressure transducers attached to a data logger, thereby providing water level measurements by two independent devices.
3. A weighted slug of known volume will be quickly inserted into the monitoring well below the water table. The water level will be measured until the water level returns to static conditions.
4. The test will be terminated in monitoring wells that do not recover significantly (>80% of static level) within one hour.

The slug test data will be analyzed using either the Cooper, Bredehoeft, and Papadopulos (1967) type curve method or the Bouwer and Rice (1976, 1989) method. The Cooper et al. analysis assumes that the monitoring well penetrates a confined aquifer, and the Bouwer and Rice method applies where unconfined conditions are prevalent.

7.4 Aquifer Pumping Test

Withdrawal and injection well test field procedures are used with appropriate analytical procedures in appropriate hydrogeological sites to determine transmissivity and storage coefficient of aquifers and hydraulic conductivity of confining beds.

7.4.1 Equipment

Discharge or injection well test methods require that water be withdrawn from or injected into a single well. This well, known as the control well, will be drilled and completed such that it transmits water to or from the aquifer (usually the entire thickness of the aquifer) at rates such that a measurable water level change will occur at observation wells. The control well should be as efficient as possible, to reduce the head loss between the aquifer and the well. Well development should be as complete as possible to eliminate additional production of sand or silt and consequent changes in well efficiency and pumping water levels during

the test. Well screen length, filter bed material, and vertical and horizontal placement will be determined by an initial evaluation of hydrologic and geologic data.

Numbers of observation wells and their distance from the control well and their screened interval will be determined by an initial evaluation of hydrologic and geologic data.

A pump capable of withdrawal of a constant or predetermined variable rate of water from the control well will be selected by the engineer. In the case of diesel-, gasoline-, or natural-gas-fueled engines, throttle settings will allow for small adjustments in pumping rates. Pumps equipped with electric motors will be able to be controlled by adjusting backpressure on the pump through a gate valve in the discharge line. The pump should be equipped with a foot valve to prevent the column pipe fluid from flowing back into the well when the pump is turned off.

A combination of a pressure transducer and electronic data logger will provide rapid measurements of water level change, and will be programmed to sample at reduced frequency late in the test (e.g. sampling over a logarithmic timescale). The pressure transducer will measure pressure changes equivalent to the range of expected water level changes. The transducer will be checked in the field by raising and lowering the transducer a measured distance in the well prior to start of the test. The transducer readings periodically with a water level meter.

7.4.2 Initial Investigation

A field reconnaissance of the site before conducting the test will be conducted to include as much detail as possible on depth, continuity, extent, and preliminary estimates of the hydrologic properties of the aquifers and confining beds. Existing wells, utilities, and any other water holding or conveying structures will be evaluated for potential disruptors to the test.

A short term preliminary test of the control well to estimate hydraulic properties of the aquifer will be conducted. From these data, the duration of the test will be estimated and a pumping rate for the field procedure will be established.

The observation wells will be tested prior to the aquifer test to ensure that they are hydraulically connected to the aquifer by performing slug tests. Wells with an unusually sluggish response will be redeveloped.

7.4.3 Procedure

Water levels in all observation wells will be measured prior to start of pumping for a period long enough to establish the pre-pumping trend. This period will be roughly equal to the

length of the test. If the trend in all of the observation wells are not similar, an evaluation will be made by the engineer on which wells will be included in the test.

If groundwater is to be drawn from the control well, discharge water will likely be contained in a fractionalization tank. In the event discharge water is permitted to infiltrate into the ground at the site, a discharge zone will be established at an appropriate distance as determined by the engineer, so the infiltration will not influence the test.

The selected pumping rate cannot cause drawdown in the control well so great that the water level drops below the well screen or the pump intake.

Regulate the rate at which water is withdrawn from, or injected into, the control well throughout the test. The short-term discharge should not vary more than 10 % about the mean discharge. For constant-discharge tests, long-term variation of discharge from the beginning to end of test generally should be less than 5 %.

Measure discharge frequently, for example every 5 minutes, and if necessary adjust discharge during the beginning of the test. When the discharge becomes more stable, reduce the frequency of adjustments and check discharge at least once every 2 hour throughout the test. Variations in electric line load throughout the day will cause variations in discharge of pumps equipped with electric motors. Changes in air temperature and barometric pressure will likewise affect diesel motors. Late in a lengthy test, measure and adjust discharge much more frequently than the water levels are measured.

Measure water levels in each observation well at approximately logarithmic intervals of time manually or with a pressure transducer and datalogger. Measure at least ten data points throughout each logarithmic interval.

The engineer will make a preliminary analysis of the aquifer-test data during the test. The test duration will continue until the system reaches steady state as determined by an appropriate analysis.

When pumping is complete, the recovery data will be monitored in selected wells over logarithmic intervals.

References

1. *Standard Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems*. 2002. American Society for Testing and Materials [ASTM] D 4050-90
2. *Standard Guide for Selection of Aquifer Test Method in Determining of Hydraulic Properties by Well Techniques* (2004), American Society for Testing and Materials [ASTM] D 4046-96.

8. Groundwater Sampling Procedure

The following is a step-by-step sampling procedure to be used to collect groundwater samples from the monitoring wells and temporary groundwater monitoring points. Well sampling procedures will be recorded in the field notebook. Sample management is detailed in the QAPP.

1. Groundwater samples will not be collected until at minimum, two weeks following well development of permanent wells.
2. Prior to sampling, a round of groundwater elevation measurements will be collected. The measurements will be made from the surveyed well elevation mark on the top of the inner PVC casing with a decontaminated electric water/product level probe. The measurements will be made in as short a time frame as practical to minimize temporal fluctuations in hydraulic conditions. The time, date, and measurement to nearest 0.01 foot will be recorded in the field logbook.
3. Place a plastic sheet on the ground to prevent contamination of the bailer rope and/or the tubing associated with the purging (pump) equipment.
4. Each monitoring well will be purged with a centrifugal, submersible, peristaltic, or whale pump and dedicated polyethylene tubing, or other methods at the discretion of the field geologist, and with the prior approval of National Grid and NYSDEC.
5. Monitoring wells will be purged at a rate to minimize drawdown within the well to the extent practicable.
6. The water quality parameters of temperature, pH, conductivity, oxygen reduction potential, turbidity, and dissolved oxygen (DO) will be measured and recorded, at 3 to 5 minute intervals with a multi-parameter water quality probe. At least, one well volume of water will be removed prior to sampling. When the parameters stabilize over three consecutive readings, sampling may commence. Stability is achieved when pH is within 0.1 standard unit, temperature is within 0.5ºC, Eh is within 10% and specific conductivity is within 10% for three consecutive readings. Record results in the field logbook prior to sample collection.
7. Collect VOC samples with a dedicated polyethylene bailer lowered by a dedicated polypropylene rope or other methods as indicated. Other parameters may be collected with a submersible or peristaltic pump using the low-flow sampling technique. The pump should be capable of throttling to a low flow rate suitable for sampling.
8. If the well goes dry before the required volumes are removed, the well may be sampled when it recovers sufficiently.

9. After all samples are collected, the water level in the monitoring well will be gauged and the locking cap will be re-installed.
10. Investigation derived water and PPE will be disposed of dedicated disposable sampling equipment in garbage bags or stored in temporary 5-gallon containers.

References

1. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples From Monitoring Wells,* published July 30, 1996 by the United States Environmental Protection Agency (EPA).

9. Surface Water Collection Procedure

Surface water sampling is not planned at this time; however, it may be included in a investigation. The following surface water collection procedure is applicable to the collection of representative surface water samples from Newtown Creek and combined storm sewer outfalls (CSOs). It includes samples collected from discrete depth intervals, as well as samples collected from the surface. This procedure may be varied or changed as required, dependent upon site conditions and equipment limitations. Any deviation from this standard will be documented in the field book and in the final report.

9.1 Sampling Methods

Location, equipment, and sampling situations will dictate the applicable method of sample collection for each point. Newtown Creek surface water and CSO sampling will generally accomplished using one of the following samplers or techniques:

- Kemmerer bottle
- Van Doren sampler
- Direct method
- Peristaltic Pump

These samplers and sampling techniques will result in the collection of representative samples from Newtown Creek.

9.2 Equipment/Apparatus

Equipment needed for collection of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Van Doren sampler
- Line and messengers
- Peristaltic Pump
- Teflon™/polyethylene tubing
- Laboratory Provided Sample bottles
- Resealable plastic bags
- Ice
- Coolers, packing material
- Chain of custody records, custody seals
- Decontamination equipment/supplies

- Maps/plot plan
- Safety equipment
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera
- Field data sheets/field notebook/waterproof pen
- Permanent marker
- Sample bottle labels
- Paper towels
- Secchi Disk
- PPE
- Global positioning system (GPS) survey equipment

9.3 Pre-Sampling Procedures

9.3.1 Sample Location

A GPS navigation system will be used to identify and record sample location coordinates. If required, the proposed locations may be adjusted based on sample location access and obstructions.

9.3.2 Water Quality Data

Water quality data will be collected during sampling from the sample depth interval using an appropriate instrument to measure pH, specific conductance, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential. In addition, water clarity will be measured at each sample location using a secchi disk. The water quality meter will be calibrated daily in accordance with manufacturer's specifications.

9.4 Sample Collection

9.4.1 Kemmerer Bottle

A Kemmerer bottle will be used in most situations to collect representative samples at the specific depths that are required. Sampling procedures are as follows:

1. Prior to sample collection, the Kemmerer bottle will be properly decontaminated. The sampling device will be set so that the upper and lower stoppers are pulled away from the body of the sampler, allowing the surface water to enter tube.
2. Lower the pre-set sampling device to the predetermined depth while avoiding disturbance of the bottom sediments.

3. When the Kemmerer bottle is at the required depth, send the weighted messenger down the suspension line, closing the sampling device.
4. Retrieve the sampler and discharge the first 10-20 milliliters (mL) from the drain to clear potential contamination from the valve.

This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

9.4.2 Van Doren Sampler

A Van Doren sampler will be used to collect surface water from a very specific sampling depth or from a shallow water body. Since the sampler is suspended horizontally, the depth interval sampled is the diameter of the sampling tube. The sampling procedure is as follows:

1. Prior to sample collection, the Van Doren Sampler will be properly decontaminated. The sampling device will be set so that the end stoppers are pulled away from the body allowing surface water to enter the tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid disturbance of the bottom.
3. When the Van Doren is at the required depth, send the weighted messenger down the suspension line, closing the sampling device.
4. Retrieve the sampler and discharge the first 10-20 mL from the drain to clear potential contamination from the valve.

This procedure may be repeated if additional sample volume is needed to fulfill analytical requirements. Subsequent grabs may be composited or transferred directly to appropriate sample containers.

9.4.3 Direct Method

For surface water samples collected within the top 6-inches of the water column, the direct method will be utilized to collect water samples directly into unpreserved the sample container(s). Analytical samples that require field preservation will be transferred from the unpreserved container to a laboratory pre-preserved sampling container.

Ensure that all samples are collected using adequate protective clothing in accordance with the site-specific HASP. Samples will be collected in a downstream to upstream direction. In shallow locations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the sediment surface during collection. The sample container will be held below the surface to avoid the collection of floating debris.

9.4.4 Peristaltic Pump

A peristaltic pump will be used to collect surface water from a very specific sampling depth or from a remote location that cannot be accessed with other sampling methods. Since the tubing can be weighted and suspended horizontally, the depth interval sampled is the opening of the sampling tubing. The sampling procedure is as follows:

1. Prior to sample collection, the tubing weights will be thoroughly decontaminated. Clean disposable Teflon™ or polyethylene tubing will be cut to the predetermined sampling depth. The outside of the tubing will be marked with appropriate gradations to determine actual sample depth. The tubing will be affixed to an YSI, In-situ Troll 9000 or similar water quality meter to ensure water quality measurements are representative of the sample interval conditions.
2. Lower the tubing and water quality meter to the predetermined sample depth. Avoid disturbance of the bottom.
3. When the tubing is at the required depth, turn on the peristaltic pump.
4. Discharge the two submerged tubing volumes from the pump to obtain a representative surface water sample.

9.5 Sample Interferences

Proper sampling procedures will be used to collect samples in accordance with this SOP to prevent cross contamination and improper sample collection. Common causes of sample interferences are listed below to ensure that the samplers can avoid potential sample collection problems.

1. Cross Contamination: Eliminated or minimized through the use of dedicated or disposable sampling equipment where appropriate. Where the use of dedicated or disposable sampling equipment is not possible or practical, the equipment will be decontaminated in accordance with the SOP for Decontamination of Field Sampling Equipment located below in Section 12.
2. Improper Sample Collection: Typical improper sample collection techniques include:
   - Improper decontamination of sampling equipment
   - Use of sampling equipment or sample containers that are not compatible with the contaminants of concern or the laboratory analytical method
   - Excess sediment in the sample due to disturbance of the Canal sediments by sampling equipment
   - Sample collection in an obviously disturbed or non-representative area
   - Sample collection during a period of increased surface water velocity that causes significant re-suspension of Canal sediments (i.e. tidal influences, storm surge)

9.6 Quality Assurance/Quality Control

QA/QC procedures that apply to the these activities include QA/QC laboratory samples including blind duplicate, matrix spike, matrix spike duplicate (MS/MSD) samples, and field blank samples. QA/QC samples are detailed in the Work Plan and the Draft QAPP. Prior to collection of the QA/QC samples, equipment will be decontaminated in accordance with procedures described in Section 12.

The following general QA procedures apply:

- All data must be documented on field data sheets or within site field notebooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented as indicated in the Draft QAPP.
- To avoid the incidental inclusion of disturbed sediment in the sample, surface water should be collected from a downstream to upstream direction and upstream of any activity that may disturb the sediment (i.e., wake from boat).

References

Wilde, F.D., D.B. Radtke, J. Gibs and R.T. Iwatsubo. 1998. National Field Manual for the Collection of Water-Quality Data - Selection of Equipment for Water Sampling. U.S. Geological Survey Techniques of Water -Resources Investigations, Book 9, Chap. A2, variously paged. http://water.usgs.gov/owq/FieldManual/index.html and http://water.usgs.gov/owq/FieldManual/mastererrat.html

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

U.S. Environmental Protection Agency. 2002. U.S. EPA Environmental Response Team, Standard Operating Procedures #2013, Surface Water Sampling. EPA, 12/17/02.

10. Sediment Sampling Procedure

The following standard sediment sampling procedure is applicable to the collection of representative sediment core samples from Newtown Creek. This procedure may be varied or changed as required, dependent upon site conditions and equipment limitations. Any deviation from this standard will be documented in the field notebook and in the final report.

10.1 Sampling Methods

Location, equipment, and sampling situations will dictate the applicable method of sample collection for each point. Sediment sampling will generally accomplished through the use of one of the following samplers or techniques:

- Ponar/Shipek Grab Sampler
- Vibracore Sampler
- Remote Sampler
- Split Spoon Sampler

These samplers and sampling techniques will likely result in the collection of representative sediment samples from Newtown Creek.

10.2 Sample Interferences

Proper sampling procedures will be used to collect samples in accordance with this SOP to prevent cross contamination and improper sample collection. Common causes of sample interferences are listed below to ensure that the samplers can avoid potential sample collection problems.

1. Cross Contamination: Eliminated or minimized through the use of dedicated or disposable sampling equipment where appropriate. Where the use of dedicated or disposable sampling equipment is not possible or practical, the equipment will be decontaminated in accordance with the SOP for Decontamination of Field Sampling Equipment located in Section 12.
2. Improper Sample Collection: Typical improper sample collection techniques include:
    - Improper decontamination of sampling equipment.
    - Use of sampling equipment or sample containers that are not compatible with the contaminants of concern or the laboratory analytical method.
    - Sample collection in an obviously disturbed or non-representative area.

10.3 Equipment/Apparatus

Equipment needed for collection of sediment samples may include (depending on technique chosen):

- Vibracore Sampling Rig
- Drill Rig
- Ponar/Shipek Sampler
- Shelby tubes
- Stainless steel sampling tools
- Drilling contractor provided sample jars
- Drilling wax
- Shelby tube end-caps
- Electrical tape
- Clean sand
- 5-gallon containers
- Pocket Penetrometer
- Torvane
- Water level indicator
- PID
- Laboratory Provided Sample bottles
- Resealable plastic bags
- Ice
- Coolers, packing material
- COC records, custody seals
- Decontamination equipment/supplies
- Maps/plot plan
- Safety equipment
- Tape measure
- Camera
- Field data sheets/field notebook/waterproof pen
- Permanent markers
- Sample bottle labels
- Paper towels
- PPE
- GPS

10.4 Pre-Sampling Procedures

10.4.1 Sample Location

A GPS navigation system will be used to identify and record sample location coordinates. The base station will be located on land based survey control point tied into the New York

State Plane coordinate system. If required, the proposed locations may be adjusted based upon access and obstructions.

10.5 Sample Collection

10.5.1 Ponar/Shipek Sampler

Surficial sediment samples will be collected from the upper 6 inches (approximate) using a Ponar or Shipek type grab sampler. Both of these sampling devices have the advantages of being relatively easy to handle and operate, readily available, moderately priced, and versatile in terms of the range of substrate types they can effectively sample. In addition, both of these grab samplers provide sufficient sample volume (7.5 or 3 cubic liters, respectively) to allow sub sampling for multiple analytes.

Careful use of grab samplers is required to avoid problems such as loss of fine-grained surface sediments from the bow wave during descent, mixing of sediment layers upon impact, lack of sediment penetration, and loss of sediment from tilting or washout upon ascent

The sampling procedure is as follows:

1. Prior to sample collection, the grab sampler will be decontaminated.
2. When deploying the grab sampler, the speed of descent should be controlled, with no "free fall" allowed. In deep waters, use of a winching system is recommended to control both the rate of descent and ascent.
3. The sampler will be carefully lowered the last few feet to minimize dispersal of fine material due to a sampler-induced shock wave.
4. At the time of the sample collection, the sample location will be surveyed with GPS survey equipment.
5. After the sample is collected, the sampling device should be lifted slowly off the bottom and raised to the surface at a slow and steady rate.
6. Sediments in direct contact with sides or teeth of the grab sampler will be excluded from samples to prevent potential contamination from the grab sampling device when possible.
7. Prior to sampling directly from the grab sampler, the overlying water will be removed by opening the jaws of the ponar slightly and allowing the water to drain. If the overlying water is turbid, then the suspended solids will be allowed to settle, if possible, prior to draining.
8. Where sampling directly from the sampler is not possible or feasible, the sampler will be slowly opened over a sample platform. The sampler will be placed such that the sample may be deposited with minimal disturbance.

9. Photograph the sample in color with a camera. Place a small label with sample field Identification number and approximate depth so that it appears in each frame.
10. Sediments will be described in accordance with the soil description procedure listed above in Section 5.
11. Place sediment samples into pre-cleaned laboratory provided jars for the appropriate analyses as determined in the work plan. Label each jar with the unique grab sample identification number and depth of the sample.
12. Place the sample containers into plastic sealable bags or bubble wrap and place them in an iced cooler until transfer shipment to the analytical laboratories. Add sample to the COC form.

If the above sampling protocols are followed, it will minimize the effects of typical disadvantages to Ponar or Shipek samplers such as possible shock wave and loss of very fine grained surface deposits, potential for water column contamination, and nearby down current sediment re-deposition. The potential does exist for larger materials such as twigs and stones to prevent jaw closure that will result in collection of unacceptable sample. In areas with significant debris in sediment, collection of a representative sediment surface sample may not be possible due to method and equipment limitations.

10.5.2 Vibracore Sampler

A Vibracore Sampler will be used to collect samples at depth that maintain a representative vertical profile of the sediment stratigraphy. The corer is slowly lowered to the substrate and vibrated into the sediments. Vibrations from the core barrel do cause minimal realignment of sediment grains; however, compaction and strata-bending are nearly eliminated.

The sample collection procedure is as follows:

1. The core location will be located via GPS and recorded in boat's navigational software and/or project field book.
2. Measure the water depth using appropriate means, such as a sounding line, marked pole or fathometer.
3. Press and vibrate the core barrel into the sediment until it is inserted 5 feet, or until refusal occurs. Note insertion length in the field book.
4. Retrieve the core barrel containing the sample.
5. With the Lexan or aluminum sleeve and the barrel held vertically in the boat, drill a hole in the Lexan or aluminum tube just above the top of the sediment column to drain off water.
6. Cut off the Lexan or aluminum tube just above the sediment surface and cap both ends.
7. Label the tube lengths with sample station codes using a permanent marker.
8. Stow the core sections upright on the boat in a vertical rack.

9. Transport core sections ashore and place in an enclosed vertical rack with ice for processing as soon as possible.

Once on shore, the cores will be transported to the Greenpoint Energy Center site for processing. Core samples for visual logging and analytical sampling shall be processed as follows:

1. Place core section on the core-processing table and secure with the cutting guides.
2. Using the metal guides, cut the core liner lengthwise using a router or other vibrating cutter tool with a guide such that the cutting bit penetrates the liner and does not cut significantly into the sediment core. Rotate the core 180 degrees and repeat the process. Disturbed sediment adjacent to the liner wall should not be sampled, but it is important not to contaminate the undisturbed interior of the core with plastic chips or other debris from the cutting process.
3. Once the liner wall is cut through along opposite sides (top and bottom of the horizontal core), use a 6-foot length of stainless steel wire to separate the core into two half-cylinders. With the core secured on the core-processing table, line the wire up along the top saw cut. Draw the wire evenly thought the core vertically until the core is separated.
4. If the core material cannot be separated using the wire, a thin rectangular stainless steel blade should be used to separate the core using a series of vertical cuts along the core's axis. Vertical cutting in discrete steps, rather than "dragging" the blade through the core, insures that the layered structure of the core is not obscured and that contaminants are not spread across layers. Between each vertical cut, decontaminate the blade as described in Section 12.
5. Arrange the two half-cylinders of the core section side-by-side, with the cut surfaces facing up. Extend a tape measure along them, starting at the original top end of the core.
6. Photograph the core in color with a camera. Insure that the wet surface of the core does not reflect light directly into the camera lens. Photograph the core section in overlapping frames; place a small label with core field identification number so that it appears in each frame. Advance the tape measure appropriately for any additional sections of the same core.
7. Sediments will be described in accordance with the soil description procedure (Section 5).
8. Collect each analytical sample, as pre-determined in the work plan, from the undisturbed core interior with a clean, stainless steel spoon or spatula. Do not sample any obviously "non-sediment" objects in the core interval; bottle caps, broken glass, sticks, large rocks, etc.
9. Place sediment samples into pre-cleaned laboratory provided jars for the appropriate analyses as determined in the work plan. Label each jar with the unique core identification number and depth of the sample.

10. Place the samples containers into plastic sealable bags or bubble wrap and place them in an iced cooler until transfer shipment to the analytical laboratories.

10.5.3 Remote Sampler

A remote sampler will be used to collect surficial sediment samples at shallow depths where either ponar/Shipek or vibracore methods are inaccessible.

The sample collection procedure is as follows:

1. Prior to sample collection, the remote sampler will be thoroughly decontaminated.
2. The remote sampler may consist of a stainless steel or Teflon scoop attached to a telescoping pole or other similar device.
3. The remote sampler is extended to the location of the sediment sample targeted for collection.
4. Once a sufficient volume of material is collected in the scoop, then the sampler should be retrieved slowly to avoid the loss of extremely fine material as the sampler passes thru the water column.
5. The sample is then transferred directly to a pre-cleaned laboratory container.
6. This process may be repeated if additional sample volume is necessary.

10.5.4 Split Spoon Sampler

Split spoon samples will be collected and logged on the drill barge. Please refer to subsections 4.4.3, 4.4.4, and 4.4.5 for further details on drilling.

10.6 Quality Assurance/Quality Control

QA/QC procedures that apply to the these activities include QA/QC laboratory samples including blind duplicate, MS/MSD samples, and field blank samples. QA/QC samples are detailed in the Work Plan and QAPP. Prior to collection of the QA/QC samples, equipment will be decontaminated in accordance with procedures described in Section 12.

The following general QA procedures apply:

- All data must be documented on field data sheets or within site field notebooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented as indicated in the QAPP.

11. Soil Vapor and Indoor Air Sampling Procedure

11.1 Soil Vapor Sample Collection

The following is a step-by-step sampling procedure to be used to collect soil vapor samples from the temporary soil vapor probes.

11.1.1 Documentation of Field Conditions

Pertinent field conditions will be documented prior to the installation of any probe locations.

- Weather information will be recorded (precipitation, temperature, barometric pressure, relative humidity, wind speed, and wind direction) at the beginning of the sampling event. Substantial changes to these conditions that may occur during the course of sampling will be recorded. The information may be measured with on-site equipment or obtained from a reliable source of local measurements (e.g., a local airport). Data will be obtained for the past 24 to 48 hours.
- A checklist will be filled out to assess the uses of volatile chemicals during normal operations of the nearby structures.
- Outdoor plot sketches will be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor air sampling locations (if applicable), and compass orientation (north).
- Any pertinent observations will be recorded, such as odors and readings from field instrumentation.

11.1.2 Soil Vapor Point Installation

The installation of the temporary soil vapor points will be in general accordance with Section 2.7.1 of the New York State Department of Health (NYSDOH) *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, dated October 2006 (herein referred to as the NYSDOH guidance document) and KeySpan's *Draft Standard Operating Procedure-Soil Vapor Intrusion for MGP Sites in New York*. Each soil vapor point will be constructed as follows:

- Six-inch stainless steel Geoprobe® AT86 series Permanent Implants (soil vapor screens) threaded to an (expendable) stainless steel anchor point.
- The implants will be fitted with inert Teflon or stainless steel tubing of laboratory or food grade quality.

- The annular space surrounding the vapor screen interval and a minimum of 6-inches above the top of the screen will be filled with a porous backfill material (e.g., glass beads or coarse silica sand) to create a sampling zone 1 foot in length.
- A hydrated bentonite surface seal will be created at the surface to minimize infiltration.

11.1.3 Soil Vapor Sample Collection

Soil vapor samples will be collected in accordance with the NYSDOH guidance document. Specifically, samples from the points will be collected as follows:

- Temporary points will be purged and sampled immediately following installation.
- Document pertinent field conditions prior to sampling as described above.
- A suction pump will be used to remove a minimum of three implant volumes from the soil vapor points prior to sampling.
- The purge rate shall not exceed 0.2 liters per minute.
- Samples will be collected in an individually laboratory certified clean 2.7-liter SUMMA® canister (or equivalent) using a certified flow controller calibrated for the anticipated sample duration (13 minutes). The regulator flow rate will not exceed 0.2 liters per minute.
- A helium tracer gas will be used to identify any potential migration or short-circuiting of ambient air during sampling as described below.
- The identification numbers for the canister and flow controller will be recorded.
- The initial canister pressure on the vacuum gauge will be recorded. These numbers and values will be recorded on the chain-of-custody form for each sample.
- The tubing from the soil vapor probe to the flow controller will be connected.
- Open the valve on the canister. The time that the valve was opened (beginning of sampling) and the canister pressure on the vacuum gauge will be recorded.
- The canister and the area surrounding the canister will be photographed.
- The vacuum pressure in the canister will be monitored routinely during sampling.
- Sample collection will be stopped when the canister still has a minimum amount of vacuum remaining. (Check with the laboratory supplying the canister and flow controller for the ideal final vacuum pressure). Typically, the minimum vacuum is between 2 and 5 inches of mercury, but not zero. If there is no vacuum remaining, the sample will be rejected and collected again in a new canister.
- The final vacuum pressure will be recorded and the canister valve closed. The date and time that sample collection was stopped will be recorded.

- The flow controller will be removed from the canister and the protective brass plug replaced.
- The labels/tags (sample name, time/date of sampling, etc.) will be attached to the canister as directed by the laboratory.
- The canister and other laboratory-supplied equipment will be placed in the packaging provided by the laboratory.
- The information required for each sample will be entered on the chain-of-custody form, including the identification numbers for the canister and flow controller, and the initial and final canister pressures on the vacuum gauge.
- Samples will be analyzed for VOCs and naphthalene via modified USEPA modified Method TO-15 and helium via ASTM D-1945, if necessary, by a New York State Environmental Laboratory Approval Program (ELAP) certified laboratory.
- The required copies of the chain-of-custody form will be included in the shipping packaging, as directed by the laboratory. A copy of the chain-of-custody will be maintained for the project file.
- The samples will be delivered or shipped to the laboratory as soon as practical.

All laboratory analytical data will be validated by a data validation professional in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, January 2005 and the USEPA Region II SOP for the Validation of Organic Data modified to accommodate the USEPA Method TO-15 and natural gas analysis by ASTM D-1945.

11.1.4 Tracer Gas Evaluation

The tracer gas evaluation provides a means to evaluate the integrity of the soil vapor probe seal and assess the potential for introduction of ambient air into the soil vapor sample.

A tracer gas evaluation will be conducted on the each temporary soil vapor probe to be sampled in the sampling event.

The following tracer gas evaluation procedure will be utilized:

- Retain the tracer gas around the sample probe by filling an air-tight chamber (such as a plastic bucket) positioned over the sample location.
- Make sure the chamber is suitably sealed to the ground surface.
- Introduce the tracer gas into the chamber. The chamber will have tubing at the top of the chamber to introduce the tracer gas into the chamber and a valved fitting at the

bottom to let the ambient air out while introducing tracer gas. Close the valve after the chamber has been enriched with tracer gas at concentrations >10%.

- The chamber will have a gas-tight fitting or sealable penetration to allow the soil vapor sample probe tubing to pass through and exit the chamber.
- After the chamber has been filled with tracer gas, attach the sample probe tubing to a pump that will be pre-calibrated to extract soil vapor at a rate of no more than 0.2 liters per minute. Purge the tubing using the pump. Calculate the volume of air in the tubing and probe and purge one to three tubing/probe volumes prior to collecting an analytical sample or using a portable device to measuring the tracer gas concentration.
- Samples collected from vapor points during a tracer gas evaluation will be analyzed for VOCs and naphthalene via modified USEPA modified Method TO-15 and helium via ASTM D-1945 by a New York State ELAP certified laboratory.
- The concentrations of the tracer gas detected during analysis or direct measurement, will determine whether additional gas tracer evaluations are necessary:

If the evaluation on a probe indicates a high concentration of tracer gas in the sample (>10% of the concentration of the tracer gas in the chamber), then the surface seal is not sufficient and requires improvement via repair or replacement prior to commencement subsequent to sample collection.

A non-detectable level of tracer gas is preferred; however, if the evaluation on a probe indicates a low potential for introduction of ambient air into the sample (<10% of the concentration of the tracer gas in the chamber), then we will proceed with the soil vapor sampling. While lower concentrations of tracer gas are acceptable, the impact of the detectable leak on sample results will be evaluated in the sampling report.

11.2 Sub-Slab Soil Vapor Collection

This procedure outlines the steps to collect sub-slab soil vapor samples (if applicable). The site-specific Sampling and Analysis Work Plan will be consulted for proposed sample locations, sample depths, and sampling duration.

Temporary sub-slab soil vapor probes will be installed using the procedures outlined below. All sub-slab soil vapor probes will be installed using a direct-push drill rig (e.g., GeoProbe™ or similar), Hand Auger, or manually using a slide hammer.

11.2.1 Documentation of Field Conditions

Document pertinent field conditions prior to installation of any probe locations.

- Weather information (precipitation, temperature, barometric pressure, relative humidity, wind speed, and wind direction) will be recorded at the beginning of the sampling event. Substantial changes to these conditions that may occur during the course of sampling will be recorded.

  The information may be measured with on-site equipment or obtained from a reliable source of local measurements (e.g., a local airport). Data will be obtained for the past 24 to 48 hours. The indoor conditions (temperature, heating/cooling system active, windows open/closed, etc.) will be recorded.

- The differential pressure at the building will be measured. The indoor and outdoor barometric pressure will be measured using a high resolution device. Where possible, the sub-slab barometric pressure will be measured at the sampling point.

- If sampling near a commercial or industrial building, uses of volatile chemicals during normal operations of the facility will be identified.

- Indoor floor plan sketches will be drawn that include the floor layout with sampling locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north), footings that create separate foundation sections, and any other pertinent information should be completed;

- Outdoor plot sketches will be drawn that include the building site, area streets, outdoor air sampling locations (if applicable), compass orientation (north), and paved areas;

- Any pertinent observations will be recorded, such as odors and readings from field instrumentation.

11.2.2 Sub-Slab Soil Vapor Point Installation Specifications

The installation of the temporary sub-slab soil vapor points will be in general accordance with Section 2.7.2 of the NYSDOH *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, dated October 2006 (herein referred to as the NYSDOH guidance document). Each sub-slab soil vapor point will be constructed as follows:

- Drill an approximately 3/8-inch hole through the slab. If necessary, advance the drill bit 2-3 inches into the sub-slab material to create an open cavity.

- Using dedicated inert Teflon or stainless steel tubing of laboratory or food grade quality, insert the inlet of the tubing to the specified depth below the slab.

- Seal the annular space between the hole and the tubing using an inert non-shrinking sealant such as melted 100% beeswax, permagum grout, putty, etc.

11.2.3 Sub-Slab Soil Vapor Sample Collection

Sub-slab soil vapor samples will be collected as indicated in the site-specific Sampling Work Plan and in accordance with NYSDOH guidance document. Specifically, sub-slab samples from the points will be collected as follows:

- Document pertinent field conditions prior to sampling as described above.
- A suction pump will be used to remove one to three implant volumes from the sub-slab soil vapor points prior to sampling. Include the volume of any additional tubing added to affix sampling equipment and the annular space between the probe and the native material if sand or glass beads were used.
- The purge rate shall not exceed 0.2 liters per minute.
- Samples will be collected in an individually laboratory certified clean 2.7-liter SUMMA® canister (or equivalent) using a certified flow controller calibrated for the anticipated sample duration (13 minutes). The regulator flow rate will not exceed 0.2 liters per minute.
- A helium tracer gas will be used to identify any potential migration or short-circuiting of ambient air during sampling as described below.
- Remove the protective brass plug from the canister. Connect the pre-calibrated flow controller to the canister.
- Record the identification numbers for the canister and flow controller.
- Record the initial canister pressure on the vacuum gauge (check equipment-specific instructions for taking this measurement). A canister with a significantly different pressure than originally recorded by the testing laboratory should not be used for sampling. Record these numbers and values on the chain-of-custody form for each sample.
- Connect the tubing from the sub-slab soil vapor probe to the flow controller.
- Open the valve on the canister. Record the time that the valve was opened (beginning of sampling) and the canister pressure on the vacuum gauge.
- Photograph the canister and the area surrounding the canister.
- Monitor the vacuum pressure in the canister routinely during sampling.
- Stop sample collection when the canister still has a minimum amount of vacuum remaining. Check with the laboratory supplying the canister and flow controller for the ideal final vacuum pressure. Typically, the minimum vacuum is between 2 and 5 inches of mercury, but not zero. If there is no vacuum remaining, the sample will be rejected and collected again in a new canister.
- Record the final vacuum pressure and close the canister valve. Record the date and time that sample collection was stopped.

- Remove the flow controller from the canister and replace the protective brass plug.
- Attach labels/tags (sample name, time/date of sampling, etc.) to the canister as directed by the laboratory.
- Place the canister and other laboratory-supplied equipment in the packaging provided by the laboratory.
- Enter the information required for each sample on the chain-of-custody form, making sure to include the identification numbers for the canister and flow controller, and the initial and final canister pressures on the vacuum gauge.
- Samples will be analyzed for VOCs and naphthalene via modified USEPA modified Method TO-15 and helium via ASTM D-1945, if necessary, by a New York State ELAP certified laboratory.
- Include the required copies of the COC form in the shipping packaging, as directed by the laboratory. Maintain a copy of the COC for the project file.
- Deliver or ship the samples to the laboratory as soon as practical.

All laboratory analytical data will be validated by a data validation professional in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, January 2005 and the USEPA Region II SOP for the Validation of Organic Data modified to accommodate the USEPA Method TO-15 and natural gas analysis by ASTM D-1945.

11.2.4 Tracer Gas Evaluation

The tracer gas evaluation provides a means to evaluate the integrity of the sub-slab soil vapor probe seal and assess the potential for introduction of indoor air into the sub-slab soil vapor sample. A tracer gas evaluation will be conducted on each temporary sub-slab soil vapor probe to be sampled in the sampling event.

The following tracer gas evaluation procedure uses helium as a tracer gas, which can be measured through laboratory analysis or with a portable detector.

- Retain the tracer gas around the sub-slab sample probe by filling an air-tight chamber (such as a plastic bucket) positioned over the sample location.
- Make sure the chamber is suitably sealed to the ground surface.
- Introduce the tracer gas into the chamber. The chamber will have tubing at the top of the chamber to introduce the tracer gas into the chamber and a valved fitting at the bottom to let the ambient air out while introducing tracer gas. Close the valve after the chamber has been enriched with tracer gas at concentrations >10%.

- The chamber will have a gas-tight fitting or sealable penetration to allow the sub-slab soil vapor sample probe tubing to pass through and exit the chamber.
- After the chamber has been filled with tracer gas, attach the sample probe tubing to a pump that will be pre-calibrated to extract sub-slab soil vapor at a rate of no more than 0.2 liters per minute. Purge the tubing using the pump. Calculate the volume of air in the tubing and purge one to three tubing volumes prior collecting an analytical sample or using a portable device to measuring the tracer gas concentration.
- Samples collected from vapor points during a tracer gas evaluation will be analyzed for VOCs and naphthalene via modified USEPA modified Method TO-15 and helium via ASTM D-1945 by a New York State ELAP certified laboratory.
- Alternately, a tracer gas detector may be used to verify the presence of the tracer gas in the chamber by affixing it to the valve fitting at the bottom of the chamber. The tracer gas detector may also be used to measure the tracer gas concentration in the pump exhaust during purging. If used, then record the tracer gas concentrations in the chamber and in the soil vapor sample.
- Based on the concentrations of the tracer gas detected during analysis or direct measurement, determine whether additional gas tracer evaluations are necessary:

If the evaluation on a probe indicates a high concentration of tracer gas in the sample (>10% of the concentration of the tracer gas in the chamber), then the surface seal is not sufficient and requires improvement via repair or replacement prior to commencement subsequent sample collection.

A non-detectable level of tracer gas is preferred; however, if the evaluation on a probe indicates a low potential for introduction of ambient air into the sample (<10% of the concentration of the tracer gas in the chamber), then proceed with the soil vapor sampling. While lower concentrations of tracer gas are acceptable, the impact of the detectable leak on sample results should be evaluated in the sampling report.

11.3 Indoor Air Sample Collection

This set of procedures outlines the steps to collect indoor air samples (if applicable). The site-specific Sampling Work Plan will be consulted for proposed sample locations, sampling duration, and other indoor air requirements (inventory, etc.).

The following procedures will be followed for the collection of indoor air samples:

11.3.1 Field Conditions Documentation

Documentation of pertinent field conditions prior to sample collection.

- Weather information (precipitation, temperature, barometric pressure, relative humidity, wind speed, and wind direction) will be recorded at the beginning of the sampling event. Substantial changes to these conditions that may occur during the course of sampling will be recorded. The information may be measured with on-site equipment or obtained from a reliable source of local measurements (e.g., a local airport). Data will be obtained for the past 24 to 48 hours. The indoor conditions (temperature, heating/cooling system active, windows open/closed, etc.) will be recorded.
- The differential pressure at the building will be measured. The indoor and outdoor barometric pressure using a high-resolution device will be measured.
- An attempt will be made to identify uses of volatile chemicals during normal operations of the nearby facilities.
- Indoor floor plan sketches will be drawn that include the floor layout with sampling locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north), footings that create separate foundation sections, and any other pertinent information will be completed;
- Outdoor plot sketches will be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor air sampling locations (if applicable), and compass orientation (north);
- Any pertinent observations will be recorded, such as odors and readings from field instrumentation.

11.3.2 Sample Collection

- Samples will be collected in an individually laboratory certified clean SUMMA® canister (or equivalent) using a certified flow controller calibrated for the anticipated sample duration (1-hour, 8-hour, etc.). The regulator flow rate will not exceed 0.2 liters per minute.
- Place the canister at the sampling location. The samples will be collected from breathing height (e.g., 3 to 5 feet above ground); therefore, the canisters will be mounted on a stable platform such that the sample inlet will be at the proper height.
- Remove the protective brass plug from canister. Connect the pre-calibrated flow controller to the canister.
- Record the identification numbers for the canister and flow controller. Record the initial canister pressure on the vacuum gauge (check equipment-specific instructions for taking this measurement). A canister with a significantly different pressure than

originally recorded by the testing laboratory should not be used for sampling. Record these numbers and values on the chain-of custody form for each sample.

- Open the valve on the vacuum pressure in the canister. Record the time that the valve was opened (beginning of sampling) and the canister pressure on the vacuum gauge.
- Photograph the canister and the area surrounding the canister.
- Monitor the vacuum pressure in the canister routinely during sampling. During monitoring, note the vacuum pressure on the gauge.
- Stop sample collection after the scheduled duration of sample collection but make sure that the canister still has a minimum amount of vacuum remaining. Check with the laboratory supplying the canister and flow controller for the ideal final vacuum pressure. Typically, the minimum vacuum is between 2 and 5 inches of mercury, but not zero. If there is no vacuum remaining, the sample will be rejected and collected again in a new canister.
- Record the final vacuum pressure and close the canister valves. Record the date and time that sample collection was stopped.
- Remove the flow controller from the canister and replace the protective brass plug.
- Attach labels/tags (sample name, time/date of sampling, etc.) to the canister as directed by the laboratory.
- Place the canister and other laboratory-supplied equipment in the packaging provided by the laboratory.
- Enter the information required for each sample on the COC form, making sure to include the identification numbers for the canister and flow controller, and the initial and final canister pressures on the vacuum gauge.
- Samples will be analyzed for VOCs and naphthalene via modified USEPA modified Method TO-15 by a New York State ELAP certified laboratory.
- Include the required copies of the chain-of-custody form in the shipping packaging, as directed by the laboratory. Maintain a copy of the COC for the project file.
- Deliver or ship the samples to the laboratory as soon as practical.

All laboratory analytical data will be validated by a data validation professional in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, January 2005 and the USEPA Region II SOP for the Validation of Organic Data modified to accommodate the USEPA Method TO-15.

References

1. *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York,* New York State Department of Health, October 2006.

2. *Draft Standard Operating Procedure-Soil Vapor Intrusion for MGP Sites in New York,* KeySpan Corporation, February 2007.

12. Equipment Decontamination Procedure

The following equipment decontamination procedure is applicable for use in decontaminating sampling tools used in collection of samples from surface soils, subsurface soils, and groundwater. Equipment decontamination will prevent cross-contamination and maintain analytical sample integrity. This procedure may be varied or changed as required, dependent upon site conditions and equipment limitations. Any deviation from this standard should be documented in the field-sampling book and in the final report.

12.1 Equipment/Apparatus

Equipment needed for decontamination of sampling equipment may include:

- Alconox or non-phosphate soap
- Simple Green
- Methanol
- 10% Nitric acid solution
- De-ionized water
- Decontamination buckets
- Secondary containment vessels
- Plastic sheeting
- Scrub brushes
- PPE

12.2 Equipment Decontamination Procedure

Equipment will be decontaminated in accordance with procedures specified in the Work Plan as summarized below.

12.2.1 Sampling Equipment and Tools

Prior to sampling, all non-dedicated equipment (i.e., bowls, spoons, bailers, and soil sampling apparatus (i.e. Macro-Core Shoe and split-spoon equipment) will be decontaminated as follows.

- Decontamination of sampling equipment and hand tools may take place at the sampling location as long as all liquids are contained in pails, buckets, etc.
- All sampling equipment will be washed with water and a non-phosphate detergent (Alconox, Simple Green, etc.) to remove gross contamination.
- All sampling equipment will then be rinsed with de-ionized water.

12.2.2 Drill Rig and Backhoe Decontamination

A decontamination pad will be constructed of High Density Polyethylene (HDPE) sheeting on a prepared surface sloped to a sump. If possible, the decontamination pad will be constructed on site, even if work is to be performed off site. If contaminated soils are encountered off site, the need for a temporary off-site decontamination pad will need to be evaluated.

The size of the pad shall be sufficient to drive the drill rig on without tearing the sides or bottom of the plastic sheet. Sides of the pad will be bermed so that all decontamination water is contained. Upon completion of all field activities, the decontamination pad will be properly decommissioned. To accomplish decommissioning, all free liquids will be removed from the surface of the HDPE sheeting, including the sump area, and allowed to air dry. The HDPE sheeting will then be cut to manageable size, folded or rolled, and placed in the waste container (roll-off container or 55-gallon drum). The wood timbers used to construct the containment berm will be inspected to ascertain if the material has come in contact with decontamination liquids during use. If they have, the materials will be steam cleaned or disposed in the waste container for subsequent disposal at an appropriate facility. If the materials have not been in contact with decontamination liquids, they may be reused.

Geoprobe® rig drilling implements will be decontaminated with water and a non-phosphate detergent and water rinse. Decontamination will be completed in close proximity to the proposed borings and will be completed over a temporary decontamination pad or plastic containers because of site constraints. The Macro-Core Sampling Shoe will be decontaminated in accordance with subsection 12.2.1.

All equipment used in intrusive work including backhoe, drilling rig, augers, bits, tools, split-spoon samplers, and tremie pipe will be cleaned with a high-pressure hot water or steam cleaning unit. The equipment will be broom-cleaned with a wire brush to remove dirt, grease, and oil before beginning fieldwork and before leaving the project Site upon completion of the last sampling activity. Tools, drill rods, and augers will be placed on sawhorses or polyethylene plastic sheets following steam cleaning. Direct contact with the ground should be minimized. The augers, rods, and tools will be decontaminated between each drilling location according to the above procedures. The backhoe bucket, arm, and any other part of the equipment, which may have contacted excavated soil, will be decontaminated between each test pit location. Decontamination water will be containerized on-site prior to disposal.

Unless sealed in manufacturers packaging, monitoring well casing and screens will be steam cleaned immediately before installation. The screen and casing shall then be wrapped in polyethylene plastic and transported from the designated decontamination area to the well location.

12.3 Quality Assurance/Quality Control

There are no specific QA activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

- All data must be documented on field data sheets or within site field notebooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

References

1. Field Sampling Plan For Site Investigations At Manufactured Gas Plants, KeySpan, March 2004.
2. U.S. Environmental Protection Agency, 1993. U.S. EPA Contract Laboratory Program – Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration. Document ILMO1.0-ILO-1.9, 1993. U.S. Environmental Protection Agency, Washington, DC.

13. Analytical Sample Handling and Transport

Soils and groundwater collected will be handled and submitted for laboratory analysis according to the following procedure. The QAPP provides a detail description of sample handling and transport.

1. Samples will be transferred from the sample equipment into suitable, labeled sample containers specific for the laboratory analyses to be performed. Use laboratory-provided, pre-preserved sample bottles for specific analyses. Do not overfill bottles if they are pre-preserved.
2. Secure the sample container with the appropriate cap, place the sample container in a resealable plastic bag or bubble wrap, and place it inside of a sample cooler provided by the laboratory. Use ice to cool the sample cooler to 4 degrees Celsius.
3. Record all pertinent sample identification data in the site database and/or field notebook.
4. Print the completed COC record from the database, sign, and photocopy. If necessary, a hard copy COC may be used in the place of the electronic database. A COC is attached in Appendix D. Place the original COC in a resealable plastic bag and affix it to the inside of the top of the cooler/or will transmitted to the laboratory courier upon a sample pick-up.
5. Attach a custody seal to the outside of the cooler prior to shipment/pickup.

14. Investigation-Derived Waste Handling Procedure

14.1 General Waste Handling Procedures

The following procedure provides guidelines for the management of investigation derived wastes. Wastes anticipated to be generated as part of the Greenpoint Energy Center Pre-Design Investigation include the following materials: subsurface soils, groundwater, decontamination fluids, PPE, and miscellaneous investigation-derived field supplies. All wastes will be segregated into sediment and subsurface soil, fluids, and PPE/miscellaneous investigation-derived materials. Investigation-derived wastes will be placed in a United States Department of Transportation (USDOT)-approved 55-gallon drum, roll-off or tank. Each waste vessel will labeled with a "Non-Hazardous Waste Label" designated with "Pending Characterization."

Information on the label should include:

Generator: National Grid
Address: Greenpoint Energy Center Site (287 Maspeth Avenue, Brooklyn, NY)

At the end of each day, each waste container should be secured and placed onto the drum containment pad. Each container should be covered and sealed at the end of waste handling activities. The field representative will document the number and type of investigation derived wastes. Investigation -derived wastes will be documented on the waste tracking sheet and provided to the National Grid PM. A waste tracking sheet is attached in Appendix E.

14.2 Investigation-Derived Waste Sample Collection Procedure

If required, the field representative will obtain a waste profile sample of soil and fluid investigation derived wastes. A sample will be collected from each of the investigation-derived wastes that require analysis for disposal. Soil wastes will be collected by using shovels, hand auger, or other equipment, composited and then placed into laboratory provided sample jars. The waste profile parameters will be provided to the field representative prior to collection of the waste profile sample. Samples will be collected into laboratory-preserved bottles, chilled with ice, and submitted to the laboratory under Chain of Custody (COC).

Reference

1. Field Sampling Plan For Site Investigations At Manufactured Gas Plants, KeySpan, March 2004.

Appendix A

Daily Activity Report

DAILY ACTIVITY REPORT **Page ___ of ___**

DATE:	**GEI Personnel:**	
PROJECT: Greenpoint Energy Center	**National Grid Personnel:**	
GEI PROJECT NO.: 081200	**Other Personnel:**	
SITE LOCATION: 287 Maspeth Ave, Brooklyn, NY	**NYSDEC Personnel:**	
	Site Visitors:	

Description of Activities and Summary of Significant Field Observations (Indicate Times as Appropriate)

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Drilling Summary

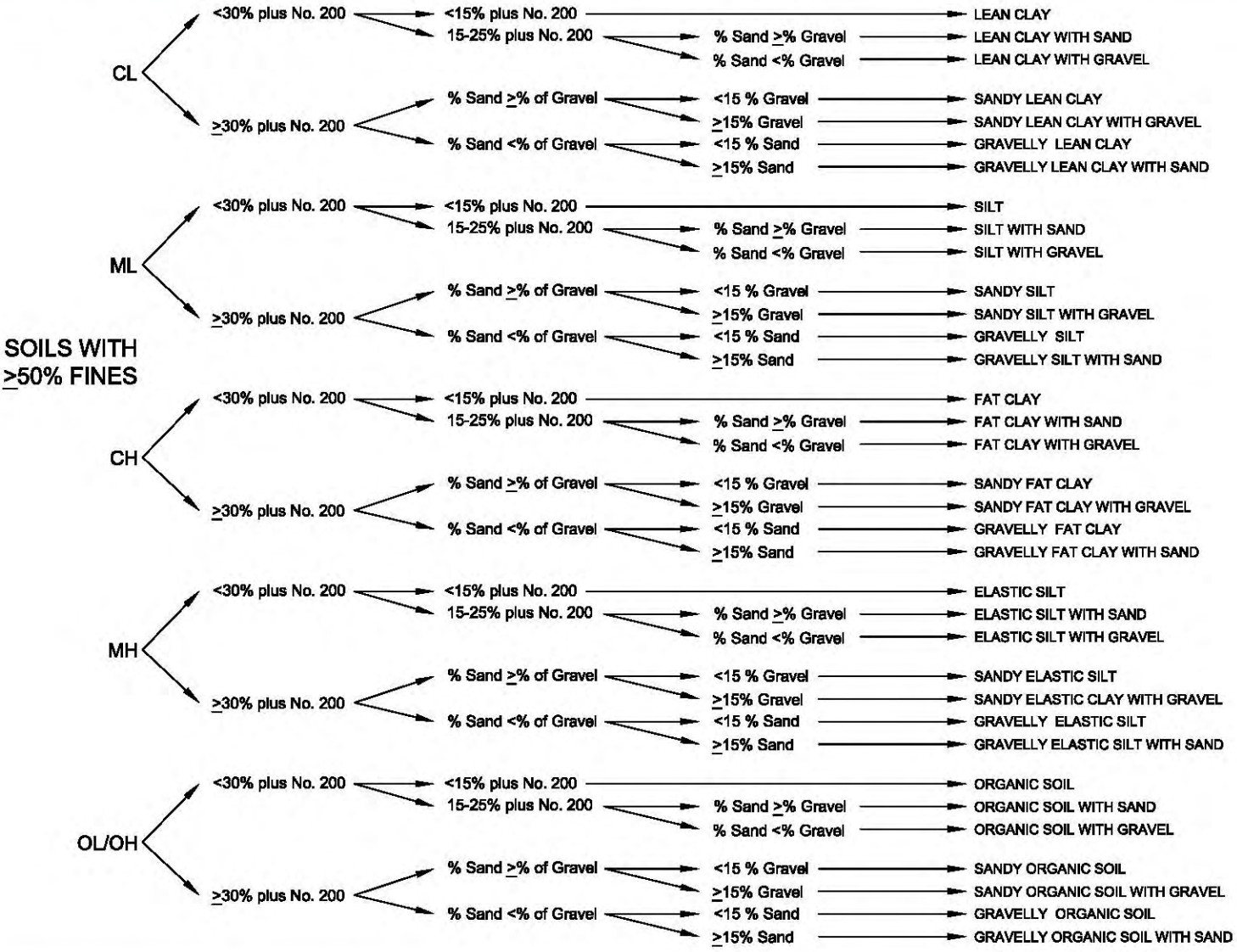
Completed Boring ID	Completed Well ID	Total Depth of Soil Sampling	Well Screen Bottom Depth	Well Screen Top Depth	Isolation Casing Depths	Other

Appendix B

Visual-Manual Description Standards

GEI Consultants

FINE-GRAINED SOILS
VISUAL-MANUAL DESCRIPTIONS



ID OF INORGANIC FINE SOILS FROM MANUAL TESTS

Symbol	Name	Dry Strength	Dilatancy	Toughness*
ML	Silt	None to low	Slow to rapid	Low or thread cannot be formed
CL	Lean Clay	Medium to high	None to slow	Medium
MH	Elastic Silt	Low to medium	None to slow	Low to medium
CH	Fat Clay	High to very high	None	High

1. GROUP NAME and (SYMBOL)
2. Describe fines, sand, and gravel components, in order of predominance. Include plasticity of fines. Include percentages of sand and gravel.
3. Color
4. Sheen, odor, roots, ash, brick, cementation, torvane and penetrometer results, etc.
5. "Fill," local name or geologic name, if known

PEAT

Peat refers to a sample composed primarily of vegetable matter in varying stages of decomposition. The description should begin: PEAT (PT) and need not include percentages of sand, gravel or fines.

CRITERIA FOR DESCRIBING PLASTICITY

Description	Criteria
Nonplastic ML	A 1/8-in. (3 -mm) thread cannot be rolled at any water content
Low Plasticity ML, MH	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit *
Medium Plasticity MH, CL	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High Plasticity CH	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

* Toughness refers to the strength of the thread near plastic limit. The lump refers to a lump of soil drier than the plastic, similar to dry strength.

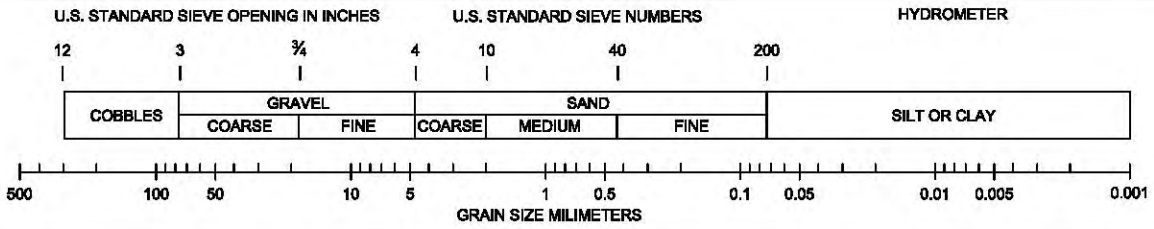
GEI Consultants

COARSE-GRAINED SOILS
VISUAL-MANUAL DESCRIPTIONS

TYPICAL SOIL COLORS

- YELLOW
- OLIVE
- LIGHT BROWN
- BROWN
- REDDISH BROWN
- RED
- GRAY
- BLACK

GROUP SYMBOL	GROUP NAME
GRAVEL (% Gravel > % Sand)	
≤5% Fines, WIDELY GRADED → GW	<15% Sand → WIDELY GRADED GRAVEL
	≥15% Sand → WIDELY GRADED GRAVEL WITH SAND
≤5% Fines, NARROWLY GRADED → GP	<15% Sand → NARROWLY GRADED GRAVEL
	≥15% Sand → NARROWLY GRADED GRAVEL WITH SAND
~10% Fines, WIDELY GRADED, Fines = ML or MH → GW-GM	<15% Sand → WIDELY GRADED GRAVEL WITH SILT
	≥15% Sand → WIDELY GRADED GRAVEL WITH SILT AND SAND
~10% Fines, WIDELY GRADED, Fines = CL or CH → GW-GC	<15% Sand → WIDELY GRADED GRAVEL WITH CLAY
	≥15% Sand → WIDELY GRADED GRAVEL WITH CLAY AND SAND
~10% Fines, NARROWLY GRADED, Fines = ML or MH → GP-GM	<15% Sand → NARROWLY GRADED GRAVEL WITH SILT
	≥15% Sand → NARROWLY GRADED GRAVEL WITH SILT AND SAND
~10% Fines, NARROWLY GRADED, Fines = CL or CH → GP-GC	<15% Sand → NARROWLY GRADED GRAVEL WITH CLAY
	≥15% Sand → NARROWLY GRADED GRAVEL WITH CLAY AND SAND
≥15% Fines, Fines = ML or MH → GM	<15% Sand → SILTY GRAVEL
	≥15% Sand → SILTY GRAVEL WITH SAND
≥15% Fines, Fines = CL or CH → GC	<15% Sand → CLAYEY GRAVEL
	≥15% Sand → CLAYEY GRAVEL WITH SAND
SOILS WITH <50% FINES	
SAND (% Sand ≥ % Gravel)	
≤5% Fines, WIDELY GRADED → SW	<15% Gravel → WIDELY GRADED SAND
	≥15% Gravel → WIDELY GRADED SAND WITH GRAVEL
≤5% Fines, NARROWLY GRADED → SP	<15% Gravel → NARROWLY GRADED SAND
	≥15% Gravel → NARROWLY GRADED SAND WITH GRAVEL
~10% Fines, WIDELY GRADED, Fines = ML or MH → SW-SM	<15% Gravel → WIDELY GRADED SAND WITH SILT
	≥15% Gravel → WIDELY GRADED SAND WITH SILT AND GRAVEL
~10% Fines, WIDELY GRADED, Fines = CL or CH → SW-SC	<15% Gravel → WIDELY GRADED SAND WITH CLAY
	≥15% Gravel → WIDELY GRADED SAND WITH CLAY AND GRAVEL
~10% Fines, NARROWLY GRADED, Fines = ML or MH → SP-SM	<15% Gravel → NARROWLY GRADED SAND WITH SILT
	≥15% Gravel → NARROWLY GRADED SAND WITH SILT AND GRAVEL
~10% Fines, NARROWLY GRADED, Fines = CL or CH → SP-SC	<15% Gravel → NARROWLY GRADED SAND WITH CLAY
	≥15% Gravel → NARROWLY GRADED SAND WITH CLAY AND GRAVEL
≥15% Fines, Fines = ML or MH → SM	<15% Gravel → SILTY SAND
	≥15% Gravel → SILTY SAND WITH GRAVEL
≥15% Fines, Fines = CL or CH → SC	<15% Gravel → CLAYEY SAND
	≥15% Gravel → CLAYEY SAND WITH GRAVEL





1. GROUP NAME and (SYMBOL)
2. Structure , if any. (stratified layer thicknesses, lenses, varves, gradational changes)
3. Describe sand, gravel and fines components, with percentages, in order of predominance. Include max gravel size. For test pits give percent cobbles and boulders, by volume, and include max size.
4. Color
5. Sheen, odor, roots, ash, brick, cementation, reaction with HCL, etc.
6. "Fill," local name or geologic name, if known

BORING LOCATION Maple Ave Sidewalk
GROUND ELEVATION (NGVD) _____
GROUNDWATER EL. _____ DATE _____
DATE START/FINISH 2/14/07 - 2/15/07
DRILLED BY Geologic: M. Costigan
LOGGED BY T. Kahl/M. Yako TOTAL DEPTH (FT) 25

B101

PG. 1 OF 1

EL. FT.	DEPTH FT.	SAMPLE TYPE and NO.	SAMPLE BLOWS PER 6 IN.	SAMPLE PEN IN.	SAMPLE REC IN.	PID JAR HS / REMARKS	GRAPHIC LOG	SOIL AND ROCK DESCRIPTIONS
	0							4" pavement
	2.5	S1	13-9 17-14	24	0	0.5 ppm	FILL	S1: Redrove 0.5 to 3.5 ft. Recovery 11": WIDELY GRADED SAND (SW) ~85% sand, ~10% gravel to 1", <5% nonplastic fines, brown. Contains brick fragments and ash. Fill.
	5					hard drilling 3 to 4 ft, possible boulder		
		S2	7-7 11-13	24	8	2.0 ppm		S2: NARROWLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) ~65% mostly fine sand, ~25% gravel to 3/4 inch ~10% non-plastic fines, brown. Fill.
	7.5	S3	9-10 2-1	24	16	0.0 ppm		S3 (0-10"): Similar to S2.
	10						ORGANICS	S3 (10"-16"): ORGANIC SILT (OL) ~100% slightly plastic fines, dark gray, organic odor, contains white shell fragments.
	12.5	S4	WOH 1-2 1	24	15	0.0 ppm		
	15					hard drilling at 15.5 ft		S4: Similar to S3, bot 6".
	17.5	S5	20-35 50/3"	15	8	Top of rock ~19 ft. Roller bit to 20 ft.	TILL	S5: SILTY SAND WITH GRAVEL (SM) ~60% mostly fine sand, ~25% slightly plastic fines, ~15% gravel to 1/2 inch, olive. Glacial Till.
	20							
	22.5	C1	RQD 70%	60	54	lost ~10 gallons drill fluid from 23 to 25 ft	ROCK	C1: SCHIST, hard, slight weathering at joint surfaces, joints at ~30 degrees from horizontal and generally parallel to foliation, gray. Marlborough Formation.
	25							Bottom of Boring 25 ft
	27.5							Truck-mounted drill rig. 4-inch casing to 19 ft. Safety-hammer with rope and cathead for SPT. Backfilled with drill cuttings.
	30							

BLOWS PER 6 IN.–140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
PEN–PENETRATION LENGTH OF SAMPLER OR CORE BARREL
REC–RECOVERY LENGTH OF SAMPLE
RQD–LENGTH OF SOUND CORES > 4 IN./ LENGTH CORED, %
S–SPLIT SPOON SAMPLE
U–UNDISTURBED SAMPLES, UF–FIXED PISTON UO–OSTERBERG
▽ GROUNDWATER

NOTES:
1: Groundwater at 10 ft depth at start of day 2/15/07.

PROJECT 07999-0
DATE

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EXAMPLE SOIL DESCRIPTIONS

SANDY SILT (ML) ~60% slightly plastic fines, ~40% mostly fine sand, 1" thick layer of fine to medium sand with <20% fines, gray.

LEAN CLAY (CL) ~90% moderately plastic fines, ~10% fine sand, olive. Boston Blue Clay. Sv = 0.5, 0.5, 0.8 tsf, Qp = 1.0, 1.5, 1.6 tsf

Stratified CLAYEY SAND (SC) and WIDELY GRADED SAND (SW) SC layers 1 to 2 inches thick consist of fine sand with ~30% moderately plastic fines, gray. SW layers 1 to 4 inches thick consist of fine to coarse sand, ~10% gravel to 1/2 inch, <5% fines, brown. Hydraulic Fill.

EXAMPLE ROCK DESCRIPTIONS

(0-9"): GRANITE, hard, one piece, joint surface slightly weathered, pink.
(6-60"): PHYLLITE, joints ~ 45° generally parallel to foliation, 9" to 44" moderate to severe jointing and joint weathering. 44" to 60" single piece, green-gray.

ARGILLITE, medium hard, moderately weathered joints, gray. Cambridge Argillite.

GEOPROBE AND ROTOSONIC

When SPTs are not performed, note sample density (sands) or stiffness (clays) in description.

CRITERIA FOR DESCRIBING DILATANCY OF FINE-GRAINED SOILS

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

SPT: Standard Penetration Test

30-inch drop with 140-lb hammer
1 3/4 to 2 1/4 turns around cathead
2-inch O.D. split spoon sampler

ENV'L TERMINOLOGY FOR SOIL DESCRIPTIONS

- **Ash** - Typically silt-size to medium sand-size.
- Do not use the term "cinders." This is not a technical term. Instead, use "ash," "burnt wood," "burnt material," or a similar term.
- **Coal-like material** - If it looks like coal but you aren't sure.
- **Clinker** - Vitrified (glass-like) or heat-fused material. Often burned impurities in coal. Often looks like pumice, but heavier.
- **Slag** - Similar to clinker, but normally refers to residue from metal ore processing.

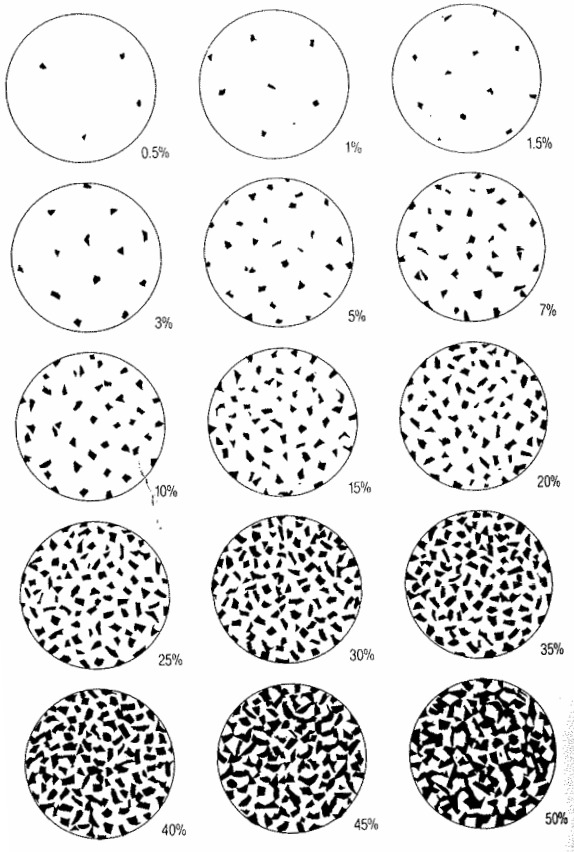
- **Sheen** - Iridescent petroleum-like sheen. Not to be used for a "bacterial sheen," which can be distinguished by its tendency to break up on the water surface at angles. Petroleum sheen will be continuous and will not break up.
- **Stained** - Use with a color ("brown-stained") to indicate that the soil is stained a color other than its natural (unimpacted) color.
- **Coated** - Soil grains are coated with NAPL (oil, tar, etc.). There is not enough NAPL to saturate the pore spaces. ("Split spoon sampler coated with brown oil." "Soil grains coated with gray substance with slight gasoline-like odor.")
- **Saturated** - The entire sample pore space is saturated with NAPL. If you use this term, be sure it is not water saturating the pore spaces. Depending on viscosity, the NAPL may drain from a soil sample. ("Sample saturated with green, sticky substance.")
- **Blebs** - Discrete sphericals of NAPL in a soil matrix that was not visibly coated or saturated. ("Occasional blebs of reddish-brown tar.")
- **Oil** - Exhibits a petroleum odor, different from MGP odors.
- **Tar** - Exhibits an MGP odor (e.g. naphthalene-like odor).

- **Odors** - Use terms such as "naphthalene-like odor" or "petroleum-like odor." Use modifiers (strong, moderate, slight) to indicate odor intensity.

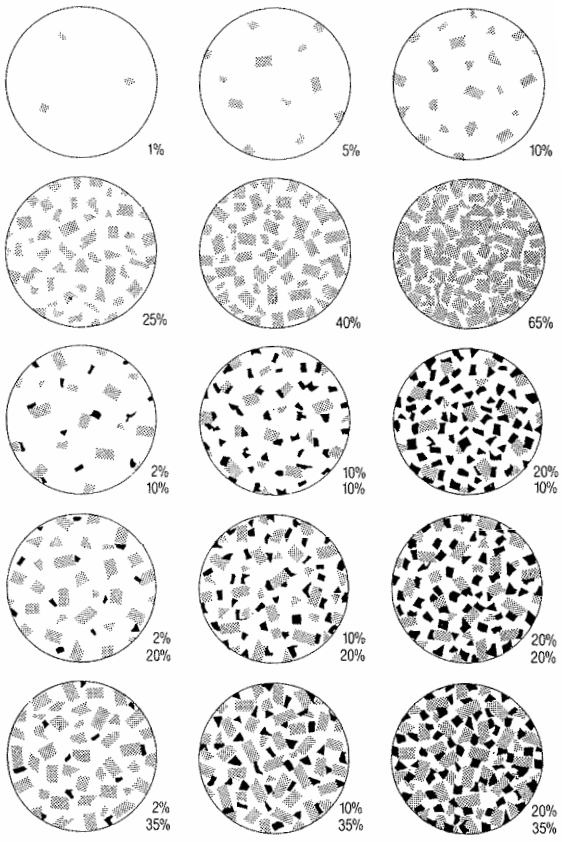
SM-003

Attachment B – Percentage Diagram for Estimating Composition By Volume

APPENDIX 3. Percentage Diagrams For Estimating Compositon By Volume*



*To convert the results to weight percentages, multiply each volume percentage by the specific gravity of that mineral and recalculate the resulting numbers so that they sum to 100.



Source: Geology in the Field, Robert F. Compton, Page 361-362, 2001

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Appendix C

Monitoring Well Information

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MONITORING WELL SAMPLING RECORD

PID Reading _____ Job Name _____

Job Number _____ By _____ Date _____

Location _____ Measurement Datum _____

Well Number _____

Pre-Development Information Time (start) _____

Water Level _____ Total Depth of Well _____

One Purge Vol _____ Three Well Volume _____

Water Characteristics

Color _____ Clear ____ Cloudy ____

Odor ____ None ____ Weak ____ Moderate ____ Strong

Any films or immiscible material ____ None

Volume (gal)	Time	pH	Temp (EC)	Spec. Conductance (ΦS/cm)	Turbidity (NTU)	DO Conc. (mg/L)	ORP (mV)	TDS

Total Volume Removed (gal) _____ pH _____

Temperature (EC) _____ Specific Conductance (ΦS/cm) _____

DO Concentration (mg/L) _____ ORP (mV) _____

_____ TDS _____

Post Development Information Time (Finished) _____

Water Level _____ Total Depth of Well _____

Approximate Volume Removed (gal) _____

Water Characteristics

Color _____ Clear ____ Cloudy ____

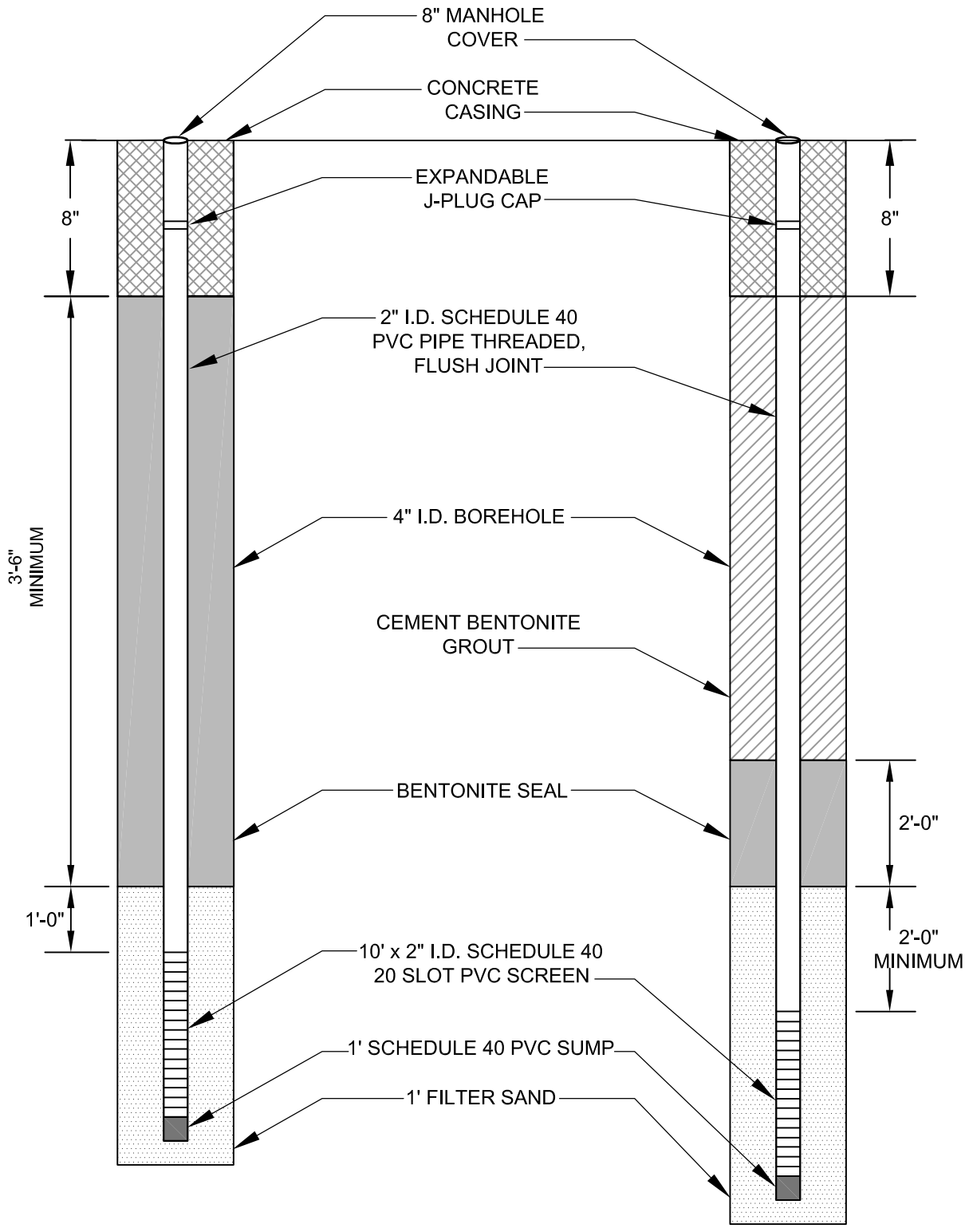
Odor ____ None ____ Weak ____ Moderate ____ Strong

Any films or immiscible material ____ None

_____

Comments:

SHALLOW ***INTERMEDIATE AND DEEP***



NOT TO SCALE

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TYPICAL SHALLOW, INTERMEDIATE AND DEEP GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL

June 2008

I:\GEI\SOPs\ Well Detail.dwg \Jun 10, 2008

Figure 1

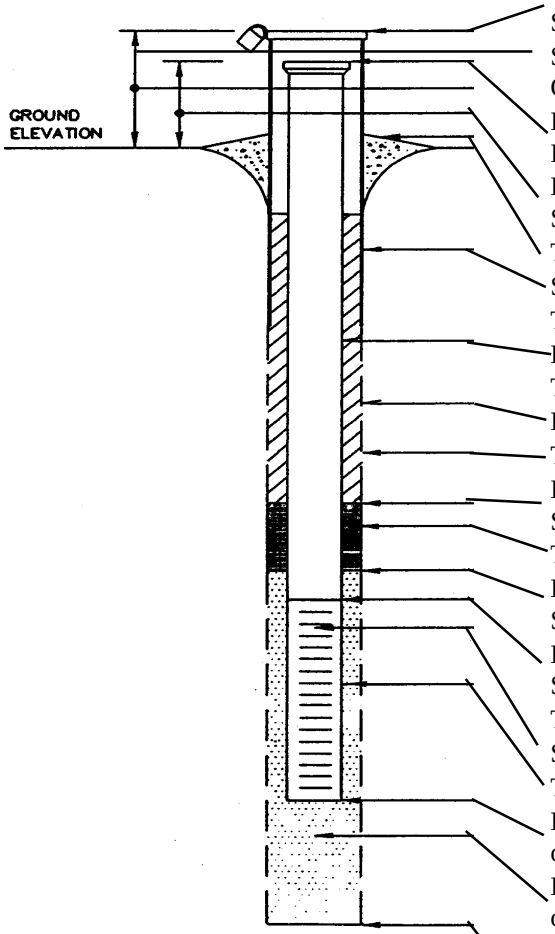
WELL INSTALLATION CHECKLIST

Project Name		Drilling Co.		Boring No.	
Project Number		Drillers		Date Started	
Project Location				Date Completed	
Site Location		Inspector			

Final depth of boring and bore hole diameter	
Depth bottom of sand pack and sand used (e.g. Morie #0)	
Type of casing (e.g. 2-in SCH 40 PVC)	
Depth bottom of screen and screen type (e.g. 10-slot)	
Depth top of screen	
Depth top of sand pack	
Depth top of seal and type of seal (e.g. cement/bentonite grout)	
Type of surface seal	
Well completion (e.g. stickup or flush mount)	

Figure 2
Overburden Monitoring Well Construction Diagram

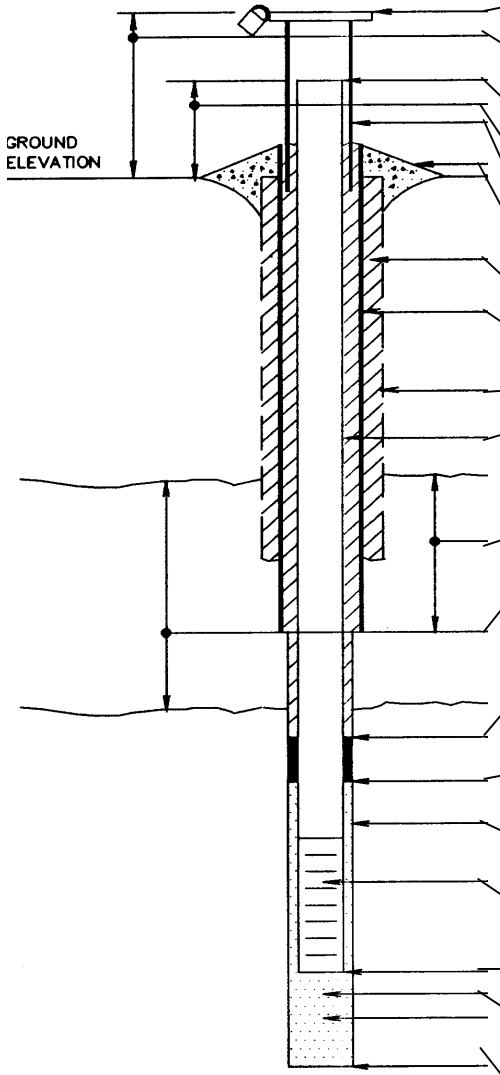
Project		Driller	
Project No.		Drilling Method	
Date		Development Method	
Elevation		Boring No.	
Field Geologist		Well No.	



Elevation of Top of Surface Casing	
Stick Up Casing Above Ground Surface	
Elevation of Top of Riser Pipe	
Riser Pipe Above Ground Surface	
Type of Surface Seal	
Surface Casing I.D.	
Type of Surface Casing	
Riser Pipe I.D.	
Type of Riser Pipe	
Borehole Diameter	
Type of Backfill	
Elevation/Depth Top of Seal	
Type of Seal	
Elevation/Depth Top of Sand Pack	
Elevation/Depth Top of Screen	
Type of Screen	
Slot Size and Length	
Type of Sand Pack	
Elevation/Depth Bottom of Screen	
Elevation/Depth Bottom of Sand Pack	
Type of Backfill Below Monitoring Well	
Elevation/Depth of Hole	
NOT TO SCALE	

Figure 3
Double Cased Monitoring Well Construction Diagram

Project		Driller	
Project No.		Drilling Method	
Date		Development Method	
Elevation		Boring No.	
Field Geologist		Well No.	



Elevation of Top of Surface Casing	
Stick Up Casing Above Ground Surface	
Elevation of Top of Riser Pipe	
Riser Pipe Above Ground Surface	
Surface Casing I.D.	
Type of Surface Seal	
Type of Surface Casing	
Upper Aquifer Casing I.D.	
Borehole Diameter/Depth	
Riser Pipe I.D.	
Type of Riser Pipe	
Type of Backfill	
Depth Casing is Set In Confining Layer	
Approximate Thickness Confining Layer	
Elevation/Depth Top of Seal	
Type of Seal	
Elevation/Depth Top of Sand Pack	
Type of Sand Pack	
Borehole Diameter/Depth	
Type of Screen	
Slot Size and Length	
Elevation/Depth Bottom of Screen	
Elevation/Depth Bottom of Sand Pack	
Type of Backfill Below Monitoring Well	
Elevation/Depth of Hole	

NOT TO SCALE

Appendix D

Chain of Custody

Chain of Custody Record

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

SEVERN TRENT **STL**
Severn Trent Laboratories, Inc.

STL-4124 (0901)

Client	Project Manager	Date	Chain of Custody Number 00732
Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page ____ of ____
City / State / Zip Code	Site Contact	Lab Contact	Analysis (Attach list if more space is needed)
Project Name and Location (State)	Carrier/Waybill Number		
Contract/Purchase Order/Quote No.			

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

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

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

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

QC Requirements (Specify)

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

Comments

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

Appendix E

Waste Tracking Form

Monthly Tracking Inventory of Former MGP Site Investigation Derived Waste:

Site Name	Address	Project Start Date(dd/mm/yy)	Project Completion Date(dd/mm/yy)	Profile samples collected(Y/N)	Description of Waste On-site			
					55-gal. Drums	Roll-Offs	Frac Tank	Miscellaneous

HEALTH AND SAFETY PLAN (HASP)

Site(s):	**GREENPOINT ENERGY CENTER SITE**
Location:	**BROOKLYN, NEW YORK**
Date Prepared:	**January 2009**
Revision:	**1.0**
Project Description:	**SOIL BORINGS, SEDIMENT BORINGS, MONITORING WELL INSTALLATION, AQUIFER TESTING, ANALYTICAL SAMPLE COLLECTION**
Waste types:	Dense non-aqueous phase liquid (DNAPL) tar, non-aqueous phase liquid (NAPL) petroleum (diesel), tar-impacted and petroleum-impacts soil and groundwater, solvents, metals, and cyanide
Characteristics:	Volatile Compounds, Toxic Compounds
Status:	Active Liquefied Natural Gas Facility (LNG)
Background Review:	Site Records Review, Liquefaction Plant Replacement Area Investigation
Overall Hazard:	Low

NATIONAL GRID, NATIONAL GRID CONTRACTORS AND SUBCONTRACTORS DO NOT GUARANTEE THE HEALTH OR SAFETY OF ANY PERSON ENTERING THIS SITE. DUE TO THE NATURE OF THIS SITE AND THE ACTIVITY OCCURRING THEREON, IT IS NOT POSSIBLE TO DISCOVER, EVALUATE, AND PROVIDE PROTECTION FOR ALL POSSIBLE HAZARDS THAT MAY BE ENCOUNTERED. STRICT ADHERENCE TO THE HEALTH AND SAFETY GUIDELINES SET FORTH HEREIN WILL REDUCE, BUT NOT ELIMINATE, THE POTENTIAL FOR INJURY AT THIS SITE. THE HEALTH AND SAFETY GUIDANCE IN THIS PLAN WAS PREPARED TO SERVE AS AN EXAMPLE TO POTENTIAL CONTRACTORS AND SUBCONTRACTORS THAT MAY WORK AT THIS SITE AND SHOULD NOT BE USED ON ANY SPECIFIC PROJECT WITHOUT PRIOR RESEARCH AND EVALUATION BY TRAINED HEALTH AND SAFETY SPECIALISTS.

CONTRACTOR CERTIFICATIONS

By their signature, the undersigned hereby certify that this HASP has been reviewed and approved for use at the National Grid Greenpoint Former Manufactured Gas Plant (MGP) site located at the Greenpoint Energy Center, Brooklyn, New York.

PROJECT MANAGER	DATE
SITE SAFETY OFFICER	DATE
CORPORATE HEALTH AND SAFETY OFFICER	DATE

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1.0 INTRODUCTION

1.1 Purpose

This Health and Safety Plan (HASP) addresses the health and safety practices that will be employed by workers participating in investigation and remediation activities at the site that are under the direction of the Consultant. This work will be performed at the National Grid Greenpoint Former Manufactured Gas Plant Site located at the Greenpoint Energy Center, Brooklyn, New York (Site). The HASP takes into account the specific hazards inherent to the Site, and presents procedures to be followed by the Consultant, Contractor, Subcontractor(s), and all site visitors in order to avoid and if necessary, protect against health and/or safety hazards.

Activities performed under this HASP will comply with applicable parts of Occupational Safety and Health Administration (OSHA) Regulations, primarily 29 CFR Parts 1910 and 1926 and attached National Grid policies and procedures. A copy this HASP will be maintained on-site for the duration of work.

All workers who may participate in activities at the Site are required to comply with the provisions specified in this HASP. All site visitors who enter designated work zones must also comply with this HASP. Refusal or failure to comply with the HASP or violation of any safety procedures by field personnel and/or subcontractors performing work covered by this HASP may result in immediate removal from the site following consultation with the Contractor.

1.2 Scope of Work

This HASP addresses all general activities listed below:

Mobilization/Demobilization

- Mobilization/Demobilization of Equipment and Supplies
- Establishment of Site Security, Work Zones and Staging Areas

Pre-Remedial Investigation Activities

- Utility survey
- Records Review
- Stormwater System Evaluation

Remedial Investigation Activities

- Installation of Soil Borings
- Installation of Sediment Borings
- Installation and Development of Monitoring Wells

- Collection of Analytical Samples
- Aquifer Testing
- Waste Handling
- Site Restoration

2.0 PROJECT ORGANIZATION AND RESPONSIBILTIES

This Section includes the project organization and structure, and establishes the specific chain of command for responsibilities and communications. The organizational structure shall be reviewed and updated as necessary to reflect the current status of project operations.

2.1 National Grid

National Grid will have final responsibility and authority for all aspects of the project, and is also responsible for approving all changes to this HASP.

A National Grid project-specific organization chart with contact information is included in Appendix A.

2.2 Consultant

Consultant provides general health and safety oversight as National Grid's Agent. The Consultant also conducts perimeter air monitoring, and work zone monitoring for Consultant employees. The Consultant will monitor daily operations, and will serve as the Contractor's primary point of contact with National Grid and regulatory agencies for health and safety related matters. Consultant health and safety roles for this project include:

- Project Manager
- Site Safety Officer
- Corporate Health and Safety Officer

Task	**Consultant**
General Health-and-Safety Oversight of the Greenpoint Energy Center Cutoff Wall Interim Remedial Measure Pre-Design Investigation, site Remedial Investigation(s),and site remedial activities.	GEI Consultants, Inc. 455 Winding Brook Drive, Suite 201 Glastonbury, CT 06033 (860) 368-5396 National Grid Program Manger: David Terry

The Consultant health and safety roles are structured the same as the Contractor Project Organization. Details of these roles are presented below in Section 2.3.

A Consultant project-specific organization chart with contact information is included in Appendix A.

2.3 Contractor

The Contractor is responsible for all work detailed in the project work plan and/or Contractor Statement of Work. The Contractor is also responsible for the health and safety of Contractor and Subcontractor employees, and conducts work zone monitoring for Contractor and Subcontractor workers. Specific Contractor health and safety roles include:

Project Manager – responsibilities include the following:

- Ensures implementation of this program
- Conducts periodic inspections
- Participates in incident investigations
- Ensures the HASP has all of the required approvals before any site work is conducted
- Ensures that the Site Safety Officer is informed of project changes which require modifications of the site health and safety plan
- Has overall project responsibility for Project Health and Safety.

Site Safety Officer (SSO) - responsibilities include the following:

- Ensures that the HASP is implemented and that all health and safety activities identified in site safety plans are conducted and/or implemented
- Ensures that field work conducted safely and enforces site health and safety rules
- Ensures that adequate communication between field crews and emergency response personnel is maintained
- Ensures that field site personnel are medically cleared and adequately trained and qualified to work at the site and that proper personal protective equipment is utilized by field teams
- Investigate and report all accidents/incidents to the project manager (PM) and to the Corporate Health and Safety Officer (CHSO)
- Conducts and documents daily safety briefings
- Stops work if necessary
- Identifies operational changes which require modifications to health and safety procedures and site safety plans, and ensures that the procedure modifications are implemented and documented through changes to the HASP, with CHSO approval
- Directs and coordinates health and safety monitoring activities

- Evaluates air monitoring data relative to site- and activity-specific action levels
- Ensures that monitoring instruments are calibrated
- Reports to the CHSO to provide summaries of field operations and progress
- Conducts routine safety inspections of their work areas
- Conducts incident investigations and together with the CHSO, prepares appropriate reports (i.e. OSHA 300 Report)
- Maintains files on all personal monitoring results, laboratory reports, calculations and air sampling data sheets
- Ensure that all necessary information including emergency phone numbers, hospital directions and warning signs are kept posted in an area accessible to all site employees
- Maintain a daily list of workers and visitors present on the site.

CHSO - responsibilities include the following:

- Provides for the development and approval of the HASP
- Serves as the primary contact to review health and safety matters that may arise
- Approves revised or new safety protocols for field operations
- Coordinates revisions of this HASP with field personnel
- Coordinates upgrading or downgrading of personal protective equipment with the SSO
- Maintains a copy of fit test certification, documents of medical clearance, and exposure reports from site activities.
- Assists in the investigation of all accidents/incidents

Site Personnel - responsibilities include the following:

- Reports any unsafe or potentially hazardous conditions to the SSO
- Maintains knowledge of the information, instructions and emergency response actions contained in the HASP
- Complies with rules, regulations and procedures as set forth in the HASP and any revisions
- Prevents admittance to work sites by unauthorized personnel
- Inspect all tools and equipment, including PPE, prior to use

A Contractor project-specific organization chart with contact information is included in Appendix A.

3.0 SITE HISTORY AND PROJECT DESCRIPTION

3.1 Location

The Greenpoint Energy Center is a 119-acre parcel bordered by Vandervoort Avenue, Lombardy Street, Maspeth Avenue, and Newtown Creek in Brooklyn, New York. A site location map is provided in Appendix B.

The surrounding area is dominated by industrial and commercial uses with the exception of a residential area near Beadel Street located to the northwest. To the north of the Greenpoint Energy Center along Lombardy Street are commercial enterprises including a trucking company, a construction and demolition debris recycling plant, a produce distribution warehouse and an architectural products facility. To the south along Maspeth Avenue are commercial enterprises including a solid waste transfer facility, a Fed Ex transfer center, a city auto impoundment lot, warehousing and a concrete facility.

Currently, the site is used as a liquefied natural gas (LNG) facility, service center, and vehicle maintenance facility operated by National Grid.

3.2 Site History

The site history of the Greenpoint Energy Center and surrounding area was developed through the review of selected historic maps, available Sanborn maps, and the historical standard operating procedure.

The site was a major gas and organic chemical production facility from 1928 until 1952. During this period of MGP operations activities on the site were known to include:

- Carburetted water gas production
- Producer gas production
- By-product coal gas production
- Gas purification
- Ammonia production
- Benzol refining
- Gas storage and distribution.

3.3 Project Description

National Grid will retain GEI and other contractors as specified in Section 2 of the HASP to perform a Cutoff Wall Interim Remedial Measure (IRM) pre-design investigation program and capital improvement environmental investigations which are components of a Remedial Investigation at the Greenpoint Energy Center in the Greenpoint

neighborhood of Brooklyn, New York. These investigations are to evaluate the nature and extent of MGP-related environmental impacts, geology, hydrogeology, and geotechnical conditions at the site.

4.0 POTENTIAL SITE HAZARDS

This section presents an assessment of potential chemical, physical, and biological hazards that may be encountered during the project work. This section also includes an activity hazard analysis (AHA) to assess and control potential site hazards for each general project task. A more detailed Contractor Project-specific AHA is included in Appendix C, which addresses the health and safety hazards of each specific project task or operation and includes requirements and procedures for worker protection. The following appendices include information on additional programs, which will be used to mitigate potential hazards:

Appendix D – Hazard Communication Program
Appendix E – Cold Stress Program
Appendix F – Heat Stress Program
Appendix G – Personal Protective Equipment Program
Appendix H – Lock Out / Tag Out Program
Appendix I – Confined Space / Hot Work Permitting Procedure

4.1 Chemical Hazards

The characteristics of compounds at the Site are discussed below for information purposes. Adherence to the safety and health guidelines in this HASP should reduce the potential for exposure to the compounds discussed below. Table 4-1 presents chemical data regarding potential exposure and monitoring for the chemical types listed below. Material safety data sheets (MSDS) for commonly used compounds and compounds that may be encountered during the investigation activities are located in Appendix K.

Some initial testing of groundwater and soils was performed at the northeast portion of the site by Paulus, Sokolowski & Sartor (PS&S) to evaluate conditions and potential risk associated with construction of the liquefaction facilities. Results from these samples are presented in Appendix K.

4.1.1 Volatile Organic Compounds (VOCs)

Volatile organic chemicals (VOCs), such as benzene, toluene, ethyl benzene, and xylene (BTEX) are present as soil and groundwater contaminants and in some cases chemical components in non-aqueous phase liquids (NAPL) such as oil or tar within soils and abandoned pipelines. These compounds generally have a depressant effect on the Central Nervous System (CNS), may cause chronic liver and kidney damage, and some are suspected human carcinogens. Benzene is a known human carcinogen. Acute exposure may include headache, dizziness, nausea, and skin and eye irritation. The primary route of exposure to VOCs is through inhalation and therefore respiratory protection is the primary control against exposure to VOCs.

4.1.2 Coal Tar and Coal Tar Products

Coal tar products, which are semivolatile organic compounds (SVOCs) consist of a mixture of acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(b)fluoranthene,

benzo(k)fluorethene, benz(a)pyrene, benzo(e)pyrene, benzo(g,h,i)peryline, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3cd)pyrene, 2-methyl naphthalene, naphthalene, phenanthrene, phenols, pyrene.

Coal tar products and other SVOCs are present at the Site within impacted soil and groundwater and as a dense non-aqueous phase liquid (DNAPL) by-product of gas production within soils, former MGP structures, and abandoned pipelines.

Coal tar products such as those listed above may cause contact dermatitis. Direct contact can be irritating to the skin and produce itching, burning, swelling and redness. Direct contact or exposure to the vapors may be irritating to the eyes. Conjunctivitis may result from prolonged exposure. Coal tar is considered to be very toxic, if ingested. High levels of exposure to coal tar, though not anticipated during work activities conducted during this project, may increase the risk of cancer including lung, kidney and skin cancer. Naphthalene is also an eye and skin irritant and can cause nausea, headache, fever anemia, liver damage, vomiting convulsions and coma. Poisoning may occur by ingestion of large doses, inhalation or skin absorption.

The major route of entry for the work activities to be conducted at this site is through direct contact. Exposure is most likely when handling soil and water samples. Inhalation may occur when the soil is disturbed causing respirable and nuisance dust particles to become airborne.

4.1.3 Heavy Metals

The Site contains elevated levels of metals including arsenic, chromium, lead, mercury, and selenium.

Exposure to arsenic can cause dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, and hyperpigmentation of skin. Chronic exposure to arsenic has resulted in lung cancer in humans.

Exposure to lead may cause acute symptoms such as eye irritation, weakness, weight loss, abdominal pain, and anemia. Chronic exposure to lead may result in kidney disease, effects to the reproductive system, blood forming organs, and CNS.

Both lead and arsenic are regulated by specific OSHA standards. They are 29 CFR 1910.1025/1926.52 and 29 CFR 1910.1018/1926.1118, respectively. These standards include specific requirements for air monitoring, signs and labels, training and medical surveillance.

Exposure to chromium can cause acute symptoms such as irritation of the eyes, nose and throat as well as wheezing and coughing. Chronic effects include nosebleeds, nasal congestion, dermatitis, and loss of sight.

Exposure to mercury can cause dizziness, salivation nausea, vomiting, diarrhea, constipation, emotional disturbance, and kidney injury. Chronic exposure to mercury can cause CNS damage.

Exposure to selenium can cause mucous membrane irritation, coughing, sneezing, shortness of breath, chills, headaches, hypotension, and CNS depression. Chronic exposure to selenium could cause bronchial irritation, gastrointestinal distress, excessive fatigue, and skin discoloration.

As with SVOCs, the primary route of exposure is through inhalation of dust particles when soil is disturbed and becomes airborne.

4.1.4 Asbestos-Containing Materials

The Site potentially contains asbestos containing materials (ACM) in the forms of demolition debris within the relief holder, ACM pipe insulation and asbestos cement pipe. Chronic exposure to asbestos may cause asbestosis and mesothelioma. The primary route of exposure for asbestos is inhalation during the disturbance and/or removal of asbestos from the pipe insulation and cement pipes.

Asbestos is strictly regulated under OSHA 29 CFR 1910.1001/1926.1101. Employees that may be potentially exposed to ACM must participate in a medical surveillance program, have specific training in the hazards and controls of exposure to asbestos and wear respirators with high efficiency particulate (HEPA) filters. All work must be conducted in demarcated regulated areas to minimize the amount of people within the exposure area. Employers must conduct air sampling and provide signs and labels regarding the presence of asbestos.

4.1.5 Polychlorinated Biphenyls

Polychlorinated Biphenyls (PCBs) have previously been encountered during MGP site investigations at other sites.

4.1.6 Cyanide

Cyanide compounds are common by-products of manufactured gas production but are also used in rat poisons, silver and metal polish, photographic solutions, fumigating solutions, and electroplating solutions. Hydrogen cyanide is toxic because it is a chemical asphyxiant. It replaces the oxygen in the blood and thereby suffocates the cells. Ferrocyanides (which are associated with purifier waste from gas manufacture) are not considered toxic because the hydrogen cyanide ion is bound tightly to the iron and cannot therefore replace the oxygen. It takes a great amount of heat and/or acid to release hydrogen cyanide gas from the ferrocyanide molecule, therefore hydrogen cyanide is not a concern at this site. However, it is National Grid policy to monitor for hydrogen cyanide during earth-disturbing activities at sites where MGP-related contaminants have been found.

4.1.7 Hydrogen Sulfide

Hydrogen sulfide is another common by-product of manufactured gas production. Exposure to lower concentrations can result in eye irritation, a sore throat and cough, shortness of breath, and fluid in the lungs. These symptoms usually go away in a few weeks. Long-term, low-level exposure may result in fatigue, loss of appetite, headaches, irritability, poor memory, and dizziness. Breathing very high levels (>800 parts per million [ppm]) of hydrogen sulfide can

cause death within just a few breaths. The primary route of exposure is through inhalation and therefore respiratory protection is the primary control against exposure to hydrogen sulfide.

4.1.8 Evaluation of Organic Vapor Exposure

Air monitoring reduces the risk of overexposure by indicating when action levels have been exceeded and when personal protective equipment (PPE) must be upgraded or changed. Action levels for volatile organic compounds and associated contingency plans for the work zone are discussed within Section 8.0 of this Health and Safety Plan.

Exposure to organic vapors shall be evaluated and/or controlled by:

- Monitoring air concentrations for organic vapors in the breathing zone with a photoionization detector (PID) or a flame ionizing detector (FID)
- When possible, engineering control measures will be utilized to suppress the volatile organic vapors. Engineering methods can include utilizing a fan to promote air circulation, utilizing volatile suppressant foam, providing artificial ground cover or covering up the impacted material with a tarp to mitigate volatile odors.
- When volatile suppression engineering controls are not effective and organic vapor meters indicate concentrations above the action levels, then appropriate respiratory protection (i.e. air purifying respirator with organic vapor cartridge) will be employed.

Table 4-1
Chemical Data

Compound	CAS #	ACGIH TLV	OSHA PEL	Route of Exposure	Symptoms of Exposure	Target Organs	Physical Data
Asbestos	1332-21-4	0.1 f/cc	0.1 f/cc over 8 hr period or 1.0f/cc over 30 min.	Inhalation Ingestion Skin Contact	Asbestosis (chronic exposure); mesothelioma, breathing difficulty, interstitial fibrosis' restricted pulmonary function, finger clubbing; irritate eyes, potential carcinogen	Respiratory system, eyes	White, greenish, blue, or gray-green fibrous solids FP: NA IP: NA LEL: NA UEL NA VP: 0 mm
Arsenic	7440-38-2	0.01 mg/m^3	0.01 mg/m^3 A.L. .005mg/m3	Inhalation Skin Absorption Ingestion Skin Contact	Ulceration of nasal septum, dermatitis, GI disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, potential carcinogen	Liver, kidneys, skin, lungs, lymphatic system	Metal: Silver-gray or tin-white, brittle, odorless solid FP: NA IP: NA LEL: NA UEL: NA VP: 0 mm
Benzene	71-43-2	0.5 ppm (Skin)	1 ppm TWA 5 ppm STEL	Inhalation Skin Absorption Ingestion Skin Contact	Irritation of eyes, skin, nose, respiratory system, giddiness, headache, nausea; staggering gait, fatigue, anorexia, weakness, dermatitis, bone marrow depression, potential carcinogen	Eyes, skin, CNS, bone marrow, blood	FP: 12^o F IP: 9.24 eve LEL: 1.2% UEL:7.8% VP: 75 mm
Chromium (Chromic Acid and Chromates)	1333-82-0	0.05 mg/m^3	0.1 mg/m^3	Inhalation Ingestion Skin Contact	Irritates respiratory system, nasal, septum perforation, liver and kidney damage, leucocytosis (increased blood leucocytes), leukopenis (reduced blood leucocytes), moncytosis (increased monocytes), Eosinophilia, eye injury, conjunctivitis, skin ulcer, sensitivity dermatitis, potential carcinongen	Blood, respiratory system, liver, kidney, eyes, skin, lung cancer	FP:NA IP:NA VP: Very Low LEL: NA UEL: NA
Ethylbenzene	100-41-4	100 ppm	100 ppm	Inhalation Ingestion Skin Contact	Eye, skin, mucous membrane irritation; headache; dermatitis, narcosis; coma	Eyes, skin, respiratory system, CNS	FP: 55^o F IP: 8.76 eV LEL: 0.8% UEL:6.7% VP: 7 mm

Table 4-1
Chemical Data

Compound	CAS #	ACGIH TLV	OSHA PEL	Route of Exposure	Symptoms of Exposure	Target Organs	Physical Data
Hydrogen cyanide	74-90-8	4.7 ppm (5 mg/m^3) STEL [skin]	10 ppm (11 mg/m^3) [skin]	Inhalation Ingestion Absorption Skin/Eye Contact	Asphyxia; weakness, headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes	CNS, CVS, thyroid, blood	Colorless or pale-blue liquid or gas (above 78°F) with a bitter, almond-like odor. VP: 630 mmHg IP: 13.60 eV
Hydrogen sulfide	7783-06-4	10 ppm TWA, 15 ppm STEL	20 ppm C, 50 ppm [10-min. Maximum peak]	Inhalation Skin/Eye Contact	Irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, fatigue, irritability, insomnia; gastrointestinal disturbance; liquid: frostbite	Eyes, respiratory system, CNS	Colorless gas with a strong odor of rotten eggs. VP: 17.6 atm IP: 10.46 eV
Lead	7439-92-1	0.050 mg/m^3	0.05 mg/m^3 A.L. 0.03 mg/m3	Inhalation Ingestion Skin Contact	Weakness, insomnia; facial pallor; pal eye, anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis of wrist and ankles; irritates eyes, hypo tension	Eyes, GI tract, CNS, kidneys, blood, gingival tissue	A heavy, ductile, soft, gray solid. FP: NA IP: NA LEL: NA UEL: NA VP: 0 mm
Mercury	7439-97-6	0.025 mg/m^3	0.10 mg/m^3	Inhalation Ingestion Skin Contact Skin Absorption	Irritates eyes and skin, chest pain, cough, difficulty breathing, bronchitis, pneumonitis, tremor, insomnia, irritability, indecision, headache, fatigue, weakness, stomatitis, salivation, Gastrointestinal disturbance, weight loss, proteinuria	Eyes, skin, respiratory tract, central nervous system	Silver-white, heavy odorless liquid FP: NA IP:? LEL: NA UEL:NA VP: 0.0012 mm

Table 4-1
Chemical Data

Compound	CAS #	ACGIH TLV	OSHA PEL	Route of Exposure	Symptoms of Exposure	Target Organs	Physical Data
Nickel	7440-02-0	1 mg/m^3	1 mg/m^3	Inhalation Ingestion Skin Contact	Dermatitis, allergy induced asthma, pneumonitis	Nasal cavities, lungs, skin	Lustrous, silvery, orderless metal solid
PAH's as Coal tar pitch Volatiles (CTPV)	65996-93-2	0.2 mg/m3	0.2 mg/m3	Inhalation Skin contact Ingestion	Irritant to eyes, swelling, acne contact dermatitis, chronic bronchitis	Respiratory system, CNS, liver, kidneys, skin, bladder, carc	Black or dark brown amorphous residue.
PCBs	11097-69-1	0.5 mg/m^3 (Skin)	0.5 mg/m^3 (Skin)	Inhalation Skin Absorption Ingestion Skin Contact	Irritate eyes; chloracne; liver damage;	Skin, eyes, liver, reproductive system	Colorless liquid or solid with a mild, hydro-carbon odor VP = 0.00006 mm
Phenol	108-95-2	10 ppm (skin)	5 ppm (19 mg/m^3) [skin]	Inhalation Skin Absorption Ingestion Skin Contact	Irritates eyes, nose, throat, anorexia, weight loss, weakness, muscle ache, pain, dark urine, cyanosis, liver and kidney damage, skin burns, dermatitis, tremors, convulsions, twitching,	Eyes, skin, respiratory system, liver, kidneys	Colorless to light pink crystalline solid with sweet, acrid odor. FP:175 ^{o}F IP:8.5 LEL:1.8% UEL: 8.6% VP: 0.4 mm
Selenium	7782-49-2	0.2 mg/m^3	0.2 mg/m^3	Inhalation Ingestion Skin Contact	Irritant to eyes, skin, nose and throat, visual disturbance, headache, chills, fever, breathing difficulty, bronchitis, metallic taste, garlic breath, GI disturbance, dermatitis, eye and skin burns,	Eyes, skin, respiratory system, liver, kidneys, blood spleen	Amphorous or crystalline, red to gray solid FP: NA IP: NA LEL: NA UEL: NA VP: 0 mm
Silica, crystalline	14808-60-7	0.05 mg/m^3	10 mg/m^3 divided by %SiO2 +2	Inhalation, Contact	Irritant to eyes, cough, wheezing, decreased pulmonary function, progressive respiratory symptoms	Eyes, reparatory system	Colorless, odorless, solid
Toluene	108-88-3	50 ppm	200 ppm	Inhalation Skin Absorption Ingestion Skin Contact	Eye, nose irritation; fatigue, weakness, confusion, euphoria, dizziness, headache; dilated pupils, tearing of eyes; nervousness, muscle fatigue, insomnia, tingling in limbs; dermatitis	Eyes, skin, respiratory system, CNS, liver, kidneys	FP: 40^{o}F IP: 8.82 eV LEL: 1.1% UEL:7.1% VP: 21 mm

Table 4-1
Chemical Data

Compound	CAS #	ACGIH TLV	OSHA PEL	Route of Exposure	Symptoms of Exposure	Target Organs	Physical Data
Vanadium dust	1314-62-1	0.05 mg/m3 (TWA)	0.1 mg /m^3 (C)	Inhalation Ingestion Skin Contact	Irritates eyes, nose, throat; green tongue, metallic taste, eczema, cough, fine rales, wheezing, bronchitis	Eyes, skin, reparatory system	Yellow-orange powder or dark gray, odorless flakes dispersed in air
Xylene	1330-20-7	100 ppm	100 ppm	Inhalation Skin Absorption Ingestion Skin Contact	Eye, skin, nose, throat irritation; dizziness, excitement, drowsiness; incoordination, staggering gait; corneal damage; appetite loss, nausea, vomiting, abdominal pain; dermatitis	Eyes, skin, respiratory system, CNS, GI tract, blood, liver, kidneys	FP: 90^o F IP: 8.56 eV LEL: 0.9% UEL: 6.7% VP: 9 mm

Abbreviations

C = ceiling limit, not to be exceeded	LEL = Lower explosive limit
CNS = Central Nervous System	mm = millimeter
CVS = Cardiovascular System	ppm = parts per million
eV = electron volt	Skin = significant route of exposure
FP = Flash point	STEL = Short-term exposure limit (15 minutes)
IP = Ionization Potential	TWA = Time-weighted average (8 hours)
GI = Gastro-intestinal	UEL = Upper explosive limit
A.L. Action Level	VP = vapor pressure approximately 68° F in mm Hg (mercury)

4.1.9 Evaluation of Respirable Dust Inhalation

Inhalation of respirable dust containing metals, crystalline silica, vanadium dust, asbestos, semi-volatiles is possible when kicking up surrounding ground cover by heavy equipment, conducting demolition work, or using power tools on surfaces that contain these materials. Contaminated particulate matter (soil, pavement, lead paint, insulation, etc.) becomes suspended in air due to a combination of factors including lack of vegetative cover and/or dry or dusty conditions. Air monitoring reduces the risk of overexposure to respirable dust inhalation by indicating when action levels have been exceeded and when PPE must be upgraded or changed. Action levels for respirable dust and associated contingency plans for the work zone and perimeter of the site are discussed within Section 8.0 of this HASP.

Control of respirable dust shall be conducted at this site as follows:

- When possible, dust control measures will be utilized to suppress the dust. These methods include wetting down the area, providing artificial ground cover or covering up the material with a tarp.
- When dust suppression is not possible and respirable dust meters indicate concentrations above the action levels, a HEPA filter must be used to prevent against inhalation of contaminated dusts.

4.1.10 Evaluation of Skin Contact and Absorption

Skin contact by contaminants may be controlled by use of proper hygiene practices, PPE and good housekeeping procedures. The proper PPE (e.g., tyveks, gloves, safety glasses) as described in Section 6 will be worn for all activities where contact with potential contaminated media or materials are expected.

4.1.11 Other Chemical Hazards

Chemicals not identified in this HASP may be used during remediation activities. Prior to the initiation of any on-site tasks, each Contractor, Subcontractor, or Consultant shall provide MSDSs to the SSO for each of the chemicals to be used. The MSDS's will be maintained on site by the SSO and all site workers and visitors who may potentially be exposed to the chemicals will be made aware of these hazards and the location of the on-site MSDS's during a hazard briefing session by the SSO.

4.2 Physical Hazards

4.2.1 High Loss Potential Physical Hazards

Activities to be conducted at the site may involve operations that have the potential for a serious injury to occur, to include the following:

- Lockout/Tagout
- Heavy Equipment Operation

- Excavation and Trenching
- Confined Space Entry
- Line Breaking
- Work within a Temporary Structure

Subsurface utilities will likely be located in the vicinity of the subsurface soil borings.

4.2.1.1 Lockout-Tagout

Site personnel will assume that all electrical equipment at surface, subsurface, and overhead locations is energized, until the equipment has been designated as de-energized by a National Grid representative. If the equipment cannot de-energized, work will stop and the SSO will consult with the PM and CHSO. The Contractor will notify National Grid prior to working adjacent to this equipment, and will verify that the equipment is energized or de-energized in the vicinity of the excavation location. The Control of Hazardous Energy Program "Lock Out/Tag Out" is included in Appendix H.

All power lines, which have been indicated by National Grid to be de-energized must be locked out, such that the lines cannot be energized when personnel are working near them. The lines shall not be unlocked and re-energized until the Contractor notifies National Grid that they have completed work in the area and that all personnel are clear of the area. National Grid representatives will thoroughly familiarize Contractor personnel with site-specific lockout/tagout procedures during the site orientation. The lockout procedures must be equivalent in effectiveness to those found in Appendix H.

If power lines cannot be de-energized, the SSO will consult with the local utility provider safety personnel to determine the safe working distance from the energized line. Work tasks will only commence after determination that a safe working distance can be maintained and all personnel working in the area have been informed of the limitation.

4.2.1.2 Heavy Equipment Operation

Heavy equipment will be operated under the following conditions:

- The operation of heavy equipment will be limited to authorized personnel specifically trained in its operation. Subcontractor site supervisors must provide this information to the SSO.
- Equipment shall be inspected daily to ensure that there are no exposed belts, fans, etc.
- When not in use, hydraulic and pneumatic components shall be left in down or “dead” position.
- Roll-over protection shall be provided on hilly terrain.

- Maintain all emergency shut-offs in sound working condition.
- The operator will use the safety devices provided with the equipment, including seat belts. Backup warning indicators and horns will be operable at all times.
- While in operation, all personnel not directly required in the area will keep a safe distance from the equipment.
- Personnel directly involved in activity will avoid moving in the path of operating equipment or any portion thereof. Areas blinded from the operator's vision will be avoided. Spotters will be used when personnel may be in areas where the operator's view is obstructed.
- Additional riders will not be allowed on equipment unless it is specifically designed for that purpose.

4.2.1.3 Excavation and Trenching

The safety requirements for each excavation must be determined by a competent person who is capable of identifying existing and predictable hazards and work conditions that are unsanitary, hazardous, or dangerous to employees. The competent person must also have the authorization to take prompt corrective measures to eliminate unsatisfactory conditions.

The following are general requirements for work activities in and around excavations:

- Prior to initiation of any excavation activity (or ground intrusive activity, such as drilling), the location of underground installations will be determined. The New York State one-call center will be contacted by the Contractor / Subcontractor a minimum of 72 hours prior to excavation activities. It may also be necessary to temporarily support underground utilities during excavation. When excavations approach the estimated location of underground installations, the exact location of the underground installations shall be determined by means that are safe to workers, i.e., hand dig, test pits, etc.
- All excavations will be inspected daily by the competent person prior to commencement of work activities. Evidence of cave-ins, slides, sloughing, or surface cracks or excavations will be cause for work to cease until necessary precautions are taken to safeguard employees.
- Excavated and other materials or equipment that could fall or roll into the excavation shall be placed at least 5 feet from the edge of the excavation.
- Vehicular traffic and heavy equipment shall remain at least four feet from the face of the excavation.
- All excavation operations will cease immediately during hazardous weather conditions such as high winds, heavy rain, lightning and heavy snow.

4.2.1.4 Excavation Entry Safety

Personnel entering a trench or excavation that is greater than 4 feet deep shall implement the following procedures:

- The sides of all excavations in which personnel will be exposed to the danger of moving ground or potential cave-in will be adequately sloped, shored or contained within a trench box, or similar support structure designed and sealed by a professional engineer.
- The air in the excavation will be tested for oxygen deficiency, explosivity, organic vapors, carbon monoxide and hydrogen sulfide. The bottom, middle, top and corners of the excavation will be tested prior to entry and continuously during excavation entry.
- Ramps or ladders will be used to provide access and sufficient egress to the excavation. Ladders must be supplied for every 25 feet of lateral travel. Ladders must be securely anchored at the top or bottom and must extend at least 3 feet above the ground surface. A competent person is required to design ramps (those used exclusively for employee access/egress). Such ramps are constructed of wood, steel or earth. Structural ramps, used for vehicle/equipment access (steel or wood) must be designed by a competent person qualified in structural design. Vehicle ramps built of earth are not considered "structural ramps".
- Employees shall not work in excavations where there is an accumulation of water or in excavations where water is accumulating unless adequate precautions have been taken to protect employees against the hazard s posed by water accumulation.
- Emergency rescue equipment such as breathing apparatus, a safety harness and line, or a basket stretcher shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation.

4.2.1.5 Working Within a Temporary Enclosure

Any work conducted within a temporary enclosure shall employ work zone and ambient monitoring in accordance with the Air Monitoring Plan and Section 8.0 of this HASP. If internal combustion engine equipment is used within the temporary enclosure, engineering controls or additional air monitoring parameters will need to be evaluated. If monitoring indicates the enclosure atmosphere meets the definition of a Permit Required Confined Space (PRCS), then the procedures of Appendix I will apply in accordance with OSHA 1910.146 and 1910.134.

4.2.2 Line Breaking

During line breaking activities, the potential exists for exposure to suspect asbestos containing materials (ACM). If suspect ACM is encountered, work will stop and will not resume until asbestos trained personnel have been upgraded to the proper PPE, and water is available to keep the work area and the suspect ACM wetted. All workers are to have completed asbestos awareness training prior to working with suspect ACM. The project management team (National Grid Project Manager, Consultant Project Manager, and Contractor Project Manager and CHSO) is to be notified if suspect ACM is encountered.

4.2.3 Fire and Explosion

Subsurface utilities including gas lines and electrical lines may be located in the vicinity of the subsurface soil borings.

When conducting excavating activities, the opportunity of encountering fire and explosion hazards also exists from contamination in the soil and the possibility of free product in the underground structures and pipelines. Additionally, the use of a diesel – powered excavating equipment could present the possibility of encountering fire and explosion hazards. Prevention and management of fire and explosion potential is addressed in the Contractor Project Specific AHA included in Appendix C of this HASP. All Contractor and Subcontractor activities shall conform with all applicable state, federal, and local regulations pertaining to fire and explosion prevention procedures.

4.2.4 Cold Stress

At certain times of the year, workers may be exposed to the hazards of working in cold environments. Potential hazards in cold environments include frostbite, trench foot or immersion foot, hypothermia as well as slippery surfaces, brittle equipment, poor judgment and unauthorized procedural changes. The procedures to be followed are found in Appendix E, the Cold Stress Program.

4.2.5 Heat Stress

Heat stress is a significant potential hazard, which is greatly exacerbated with the use of PPE in hot environments. The potential hazards of working in hot environments include dehydration, cramps, heat rash, heat exhaustion, and heat stroke. A heat stress prevention program will be implemented when ambient temperatures exceed 70ºF for personnel wearing impermeable clothing. The procedures to be followed are found in Appendix F, the Heat Stress Program.

4.2.6 Noise

Noise is a potential hazard associated with the operation of heavy equipment, power tools, pumps and generators. Site workers who will perform suspected high noise tasks and operations for short durations (less than 1-hour) shall wear earplugs. If deemed necessary by the SSO, the CHSO will be consulted on the need for additional hearing

protection and the need to monitor sound levels for site activities. Other workers who do not need to be in proximity of the noise should distance themselves from the equipment generating the noise.

4.2.7 Hand and Power Tools

In order to complete the various tasks for the project, personnel will utilize hand and power tools. The use of hand and power tools can present a variety of hazards, including physical harm from being struck by flying objects, being cut or struck by the tool, fire, and electrocution. Work gloves, safety glasses, and hard hats will be worn by the operating personnel at all times when utilizing hand and power tools and GFI-equipped circuits will be used for all power tools.

4.2.8 Slips, Trips, and Falls

Working in and around the site will pose slip, trip and fall hazards due to slippery surfaces that may be oil covered, or from surfaces that are wet from rain or ice. Excavation at the sites will cause uneven footing in the trenches and around the spoil piles. Contractors shall employ good work practice and housekeeping procedures to minimize the potential for slip, trip, and fall hazards.

4.2.9 Manual Lifting

Manual lifting of heavy objects such as sections of pipe may be required. Failure to follow proper lifting technique can result in back injuries and strains. Site workers should use power equipment to lift heavy loads whenever possible and should evaluate loads before trying to lift them (i.e. they should be able to easily tip the load and then return it to its original position). Carrying heavy loads with a buddy and proper lifting techniques include: 1) make sure footing is solid, 2) make back straight with no curving or slouching, 3) center body over feet, 4) grasp the object firmly and as close to your body as possible, 5) lift with legs, and 6) turn with your feet, don't twist. In addition, hand digging may present lifting/ergonomic hazards.

4.2.10 Steam, Heat, Splashing

Exposure to steam/heat/splashing hazards can occur during steam cleaning activities. Exposure to steam/heat/splashing can result in scalding/burns, eye injury, and puncture wounds. Proper PPE will be worn during all steam cleaning activities including rain gear or Tyvek, hardhat equipped with splashguard, and water resistant gloves and boots.

4.2.11 Boat Safety

Sediment investigation work will be conducted on a sampling vessel and/or barge within the Newtown Creek. Boat safety practices will be conducted in general accordance with guidance provided in the USACE Safety and Health Requirements Manual (EM) 385-1-1. Personnel will board the barge at specified locations to be determined and agreed upon

by National Fuel, OSI, and GEI. Safe access, as specified USACE Safety and Health Requirements Manual (EM) 385-1-1, Section 19.B, will be provided by OSI to board and get off the barge.

Type III Personal Floatation Devices (PFDs) will be worn by boat/barge occupants at all times when working over water.

For retrieving a person overboard, OSI will throw a life ring and line, and use a ladder attached to the barge or the support boat step transom to allow the person to climb out of the water. For retrieving a person overboard, the support boat will also be equipped with a life ring attached to approximately 90 feet of rope. The barge and the support boat will be equipped with an ABC rated fire extinguisher(s).

Emergency procedures for fire and man overboard will be reviewed on the first day of operations and any time a change of personnel occurs.

4.3 Biological Hazards

During the course of the project, there is a potential for workers to come into contact with biological hazards such as animals, insects and plants. Workers should be aware of these potential hazards that are discussed below.

4.3.1 Animals

During the conduct of site operations, wild animals such as stray dogs or cats, raccoons, and mice may be encountered. Workers shall use discretion and avoid all contact with wild animals. If these animals present a problem, efforts will be made to remove these animals from the site by contacting a licensed animal control technician.

4.3.2 Insects

Insects, including bees, wasps, hornets, mosquitoes, ticks, and spiders, may be present at the Site making the chance of a bite possible. Some individuals may have a severe allergic reaction to an insect bite or sting that can result in a life threatening condition. Some insect bites can transmit diseases such as Lyme Disease or a virus such as West Nile; any individuals who have been bitten or stung by an insect should notify the SSO. The following is a list of preventive measures:

- Apply insect repellent prior to performing any field work and as often as needed throughout the work shift
- Wear proper protective clothing (work boots, socks and light colored pants)
- When walking in wooded areas, avoid contact with bushes, tall grass, or brush as much as possible

- Field personnel who may have insect allergies shall have bee sting allergy medication on site and should provide this information to the SSO prior to commencing work

4.3.2.1 Lyme Disease

Lyme disease is caused by infection from a deer tick that carries a spirochete. During the painless tick bite, the spirochete may be transmitted into the bloodstream often after feeding on the host for 12 to 24 hours. The ticks that cause the disease are often no bigger than a poppy seed or a comma in newsprint. The peak months for human infection are from May to September.

Symptoms appear in three stages. First symptoms usually appear from 2 days to a few weeks after a person is bitten by an infected tick. Symptoms usually consist of a ring-like red rash on the skin where the tick was attached. The rash is often bulls-eye like with red on the outside and clear in the center. The rash may be warm, itchy, tender, and/or "doughy." Unfortunately, this rash appears in only 60 to 80% of infected persons. An infected person also has flu-like symptoms of a stiff neck, chills, fever, sore throat, headache, fatigue and joint pain. These symptoms often disappear after a few weeks. The second stage symptoms, which occur weeks to months later include meningitis, severe headache, drooping of the muscles on the face, called Bell's Pals, encephalitis, numbness, withdrawal and lethargy. These symptoms may last for several weeks to several months. Third stage symptoms, which occur months or years later include arthritis, heart problems, and loss of memory. The third stage symptoms may mimic multiple sclerosis and Alzheimer's disease.

It is recommended that personnel check themselves when in areas that could harbor deer ticks, wear light color clothing and visually check themselves and their buddy when coming from wooded or vegetated areas. If a tick is found biting an individual, the SSO should be contacted immediately. The tick can be removed by pulling gently at the head with tweezers. If tweezers are not available, cover your fingers (e.g. tissue paper) and use to grasp the tick. It is important to grasp the tick as close to the site of attachment and use a firm steady pull to remove it. Wash hands immediately after with soap and water. The affected area should then be disinfected with an antiseptic wipe. All mouth parts must be removed from the skin. If the tick is removed with breaking off the mouth parts, an irritation or infection may occur. Also, the organism that is causing the disease can still enter the body through the skin. The employee will be offered the option for medical treatment by a physician, which typically involves antibiotics. If personnel feel sick or have signs similar to those above, they should notify the SSO immediately.

Treatment with antibiotics is effective and recovery is usually complete. In the first stage antibiotics are usually given orally. Second and third stage treatment, however is

prolonged and recovery may take longer. Antibiotic treatment is usually provided intravenously for second and third stage Lyme disease.

4.3.2.2 West Nile Virus

West Nile Virus (WNV) is a mosquito-borne infection transmitted through the bite of an infected mosquito. The symptoms of WNV can be asymptomatic (no symptoms) or in more serious cases can lead to West Nile fever. West Nile Fever can include fever, headache, tiredness, body ache, an occasional rash on the trunk of the body, and swollen lymph glands, In severe cases, people have developed West Nile encephalitis or meningitis which symptoms include fever, headache, neck stiffness, tremors, coma and in some cases death. The incubation period for the disease is usually 2 to 15 days. The symptoms can range from a few days to several weeks.

Since the initial outbreak in 1999, the virus has spread rapidly throughout New York State. There are about 65 different species of mosquitoes in New York State, but only a small percentage has been associated with the WNV. Most mosquitoes are not infected and the chance of infection from a mosquito bite of an on-site worker is very small. All residents of areas where virus activity has been identified are at risk of getting WNV, but those of the highest risk for becoming seriously ill from WNV are people are over 50 and individuals with some immunocompromised person (transplant patients).

The following precautions will be used to help reduce the risk of mosquito bites:

- Reduce mosquito-breeding areas by making sure wheelbarrows, buckets, and other containers are turned upside down when not used so that they do not collect standing water.
- Wear shoes, long pants with bottoms tucked into boots or socks, and a long-sleeved shirt when outdoors for long periods of time, or when many mosquitoes are most active (between dawn and dusk).
- Use mosquito repellant according to the manufacturer’s directions when outdoors for long periods of time and when mosquitoes are most active.

4.3.3 Plants

The potential for contact with poisonous plants exists when performing fieldwork in undeveloped and wooded areas. Poison ivy, sumac, and oak may be present on site. Poison ivy can be found as vines on tree trunks or as upright bushes. Poison ivy consists of three leaflets with notched edges. Two leaflets form a pair on opposite sides of the stalk, and the third leaflet stands by itself at the tip. Poison ivy is red in the early spring and turns shiny green later in the spring. Poison sumac can be present in the form of a flat-topped shrub or tree. It has fern-like leaves, which are velvety dark green on top and pale underneath. The branches of immature trees have a velvety "down." Poison sumac

has white, "hairy" berry clusters. Poison oak can be present as a sparingly branched shrub. Poison oak is similar to poison ivy in that it has the same leaflet configuration; however, the leaves have slightly deeper notches. Prophylactic application of Tecnu® may prevent the occurrence of exposure symptoms. Post exposure over the counter products are available and should be identified at the local pharmacist. Susceptible individuals should identify themselves to the SSO.

Contact with poison ivy, sumac, or oak may lead to a skin rash, characterized by reddened, itchy, blistering skin which needs first aid treatment. If you believe you have contacted one of these plants, immediately wash skin thoroughly with soap and water, taking care not to touch your face or other body parts.

4.3.4 Blood Poisoning

Blood poisoning is a term used to indicate a large number of bacteria present in the circulating blood. The most common symptom of blood poisoning is the reddening of skin which advances toward the heart. For example, if the point of contact is the hand, then a red line will appear at the hand and extend up the arm towards the heart.

Signs and symptoms include swelling, stiffness and tenderness in the affect area, fatigue chills and fever, pustules, abscesses. If allowed to progress without treatment, the organisms may multiply and cause an overwhelming infection which can lead to death.

Personal protective equipment shall be worn to prevent direct contact with equipment that may be contaminated with bacteria such as well caps and soil.

4.3.5 Sewage and Bacterial Impacted Sediments

Newtown Creek has served as a combined sewer overflow and consequently has received untreated sanitary sewage from numerous outfalls throughout the canal. Decomposed sewage will potentially be encountered within canal sediments. Potential bacteria species in Newtown Creek sediments include soil and marine microorganisms, and bacterium associated with sewage. Many of these bacterium can cause illness through ingestion, direct contact, or the inhalation of a bio-aerosol. Potential respiratory exposure to biological agents can also occur through the inhalation of aerosols produced during sediment handling activities. Personal protective equipment as specified in Section 6.0 will be worn to minimize potential exposures. Personal will use decontamination procedures identified in Section 10.0.

4.4 Hazard Analysis

This section includes an AHA to assess and control potential site hazards for each general project task. A more detailed Contractor Project-specific AHA is included in

Appendix B, which addresses the health and safety hazards of each specific project task or operation and includes requirements and procedures for worker protection.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
Activity: Pre-Investigation and Utility Clearance		
Site Mobilization/Activity	Biological Hazards.	Proper clothes, body inspections, insect repellant.
	Slip, Trip, Fall Hazards	Identify and repair potential tripping hazards. Maintain safe and orderly work areas.
	Traffic Hazards	Use traffic cones, signage, and traffic safety vests in accordance with New York City Traffic Regulations. Use a traffic spotter.
	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Noise	Distancing form noise, hearing protection
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
Activity: Test Pit Installation and Sample Collection		
Test Pit Installation and Sample Collection	Heavy Equipment / Proximity to Heavy Equipment	Distancing, safe work practices, inspections, wear hearing protection.
	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.
	Noise	Distancing form noise, hearing protection
	Traffic Hazards	Use traffic cones, signage, and traffic safety vests in accordance with New York City Traffic Regulations. Use a traffic spotter.
	Tool Use	Use proper guarding, inspections, wear safety glasses with side shields, hearing protection.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
	Contaminant Contact	Wear protective coveralls (e.g., Tyvek®) (if needed) with shoe covers, nitrile gloves, and safety glasses when handling samples. Dispose of gloves after sampling. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated soils	Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide and hydrogen cyanide), and dust monitor to monitor the work zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist, then upgrade to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of the HASP. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the RI Work Plan and Appendix K of this HASP.
Activity: Subsurface Boring/Monitoring Well Installation and Sample Collection		
Subsurface Boring/ Monitoring Well Installation and Sample Collection	Heavy Equipment / Proximity to Heavy Equipment	Distancing, safe work practices, inspections, wear hearing protection.
	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
	Noise	Distancing form noise, hearing protection
	Traffic Hazards	Use traffic cones, signage, and traffic safety vests in accordance with New York City Traffic Regulations. Use a traffic spotter.
	Tool Use	Use proper guarding, inspections, wear safety glasses with side shields, hearing protection.
	Contaminant Contact	Wear protective coveralls (e.g., Tyvek®) (if needed) with shoe covers, nitrile gloves, and safety glasses when handling samples. Dispose of gloves after sampling. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated soils	Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide and hydrogen cyanide), and dust monitor to monitor the work zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist, then upgrade to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of the HASP. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the RI Work Plan and Appendix K of this HASP.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
Activity: Surface Soil Sample Collection		
	Contaminant Contact	Wear nitrile gloves, and safety glasses when installing points. Dispose of gloves after installation. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated soils	Use work zone air monitoring equipment including photoionization detector. If air monitoring action levels are exceeded, then engineering controls will be implemented.
Activity: Soil Vapor Point Installation and Sampling		
Soil Vapor Point Installation and Sampling	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.
	Noise	Distancing form noise, hearing protection
	Tool Use	Use proper guarding, inspections, wear safety glasses with side shields, hearing protection.
	Contaminant Contact	Wear nitrile gloves, and safety glasses when installing points. Dispose of gloves after installation. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated soils	Use work zone air monitoring equipment including photoionization detector. If air monitoring action levels are exceeded, then engineering controls will be implemented.
Activity: Hydraulic Conductivity Testing		
Hydraulic Conductivity Testing	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.
	Contaminant Contact	Wear nitrile gloves when sampling points. Dispose of gloves after installation. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated groundwater	Use work zone air monitoring equipment including photo-ionization detector. If air monitoring action levels are exceeded, then engineering controls will be implemented.
Activity: Survey		
Survey	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.
	Traffic Hazards	Use traffic cones, signage, and traffic safety vests as needed.
Activity: Sediment Boring and Surface Water Sample Collection		
Moving barge to exploration locations; set up barge to sample by lowering anchors.	Interaction with other boat traffic. Drowning.	Wear PFD. Follow USGC Safe Boating Practices. Radio for communications

WORK TASK	POTENTIAL HAZARDS	CONTROLS
Advancing borings and sampling.	Subsurface hazards (utilities especially).	Review available utility plans and evaluate geophysical survey data obtained during bathymetry survey. Visually confirm clearance from known utilities.
	Contact with equipment, especially moving parts. Overhead hazard (rods).	Stay alert and maintain suitable clearance from moving and overhead equipment. Do not wear loose clothing, jewelry, or equipment, which could get caught by moving equipment. Inspect equipment daily. Train all personnel on use of emergency shutoff switches.
	Weather related equipment hazards (slippage in rain, lightning).	Cease operations prior to and during electrical storms. Cease operations if equipment cannot be operated safely under wet conditions.
	Slip/trip/fall.	Keep trafficked areas on boat or barge free of slip/trip/fall hazards.
	Drowning.	Wear PFD.
	Loud noise (outboard motor, generator, VC sampler).	Use hearing protection during the operation of equipment that produces loud noise.
	Contact with contaminated surface water or sediments.	Wear protective coveralls (e.g. Tyvek®) with shoe covers, nitrile gloves, safety glasses and face shield when handling samples. Dispose of gloves after sampling. Wash hands. If exposed, immediately wash exposed skin with antibacterial wipes and antibacterial gel.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
Lift and secure anchors. Relocate to next exploration location.		Wear P100 disposable respirator and nitrile gloves during sediment handling manipulation. Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide, and hydrogen cyanide) to monitor the works zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist then change to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of this HASP.

5.0 TRAINING

5.1 General Health and Safety Training

In accordance with 29 CFR 1910.120, hazardous waste site workers shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations unless otherwise noted in the above reference. At a minimum, the training shall have consisted of instruction in the topics outlined in the standard. Personnel who have not met the requirements for initial training shall not be allowed to work in any site activities in which they may be exposed to hazards (chemical or physical). Proof of training shall be submitted to the SSO prior to the start of field activities.

5.2 Annual Eight-Hour Refresher Training

Annual eight-hour refresher training will be required of all hazardous waste site field personnel in order to maintain their qualifications for fieldwork. The training will cover a review of 29 CFR 1910.120 requirements and related company programs and procedures. Proof of current 8-hour refresher training shall be submitted to the SSO prior to the start of field activities.

5.3 Supervisor Training

Personnel acting in a supervisory capacity shall have received 8 hours of instruction in addition to the initial 40 hours training.

5.4 Site Safety Officer (SSO)

The SSO shall have completed the following training and work experience prior to the commencement of site activities:

- One year of construction experience
- 40-Hour Hazardous Materials training course

Training specific to work activities (i.e., excavation and trenching activities, lock out/tag out, etc.

5.5 Site-Specific Training

Prior to commencement of field activities, the SSO will ensure all field personnel assigned to the project will have completed training that will specifically address the activities, procedures, monitoring, and equipment used in the site operations. It will include site and facility layout, hazards and emergency services at the site and will highlight all provisions contained within this HASP. This training will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and operations for their particular activity. Personnel that have not received site-specific training will not be allowed on-site.

5.6 On-Site Safety Briefings

Project personnel and visitors will be given health and safety briefings daily by the SSO to assist site personnel in safely conducting work activities. The briefings will include information on new operations to be conducted, changes in work practices or changes in the site's environmental conditions, as well as periodic reinforcement of previously discussed topics. The briefings will also provide a forum to facilitate conformance with safety requirements and to identify performance deficiencies related to safety during daily activities or as a result of safety inspections. The meetings will also be an opportunity to periodically update the crews on monitoring results.

5.7 First Aid and CPR

The SSO will identify individuals certified in first aid and CPR, or identify individuals for such training in order to ensure that emergency medical treatment is available during field activities. The training will be consistent with the requirements of the American Red Cross Association and will include training on blood borne pathogens.

5.8 Hazard Communication

Hazard communication training will be provided in accordance with the requirements contained in the Hazard Communication Program in Appendix D.

6.0 PERSONAL PROTECTIVE EQUIPMENT

The PPE specified in Table 6-1 represents PPE selection required by 29 CFR 1910.132, and is based on the AHA of Section 4. Specific information on the selection rationale for each activity can be found under Appendix F - PPE Program.

The PPE program addresses elements, such as PPE selection based on site hazards, use and limitations, donning and doffing procedures, maintenance and storage, decontamination and disposal, training and proper fitting, inspection procedures prior to / during / and after use, evaluation of the effectiveness of the PPE program, and limitations during temperature extremes, heat stress, and other appropriate medical considerations.

A summary of PPE for each level of protection is as follows:

Safety Equipment	Level A	Level B	Level C	Level D
Tyvek™ suit or work overalls				•
Hard hats with splash shields or safety glasses			•	•
Steel-toe boots with overboots			•	•
Chemical-resistant gloves as appropriate for work being performed and materials handled			•	•
Half- or full-face respirators with organic/HEPA cartridges as approved by the SSO			•	
Tyvek™ splash-resistant suit			•	
Chemical-resistant clothing		•		
Pressure-demand, full-face SCBA or pressure-demand supplied air respirator with escape SCBA	•	•		
Inner and outer chemical-resistant gloves	•	•		
Chemical-resistant safety boots or shoes	•	•		
Two-way radio	•	•		
Hard hat	•	•		
Fully encapsulating chemical-resistant suit	•			

Table 6-1 describes the anticipated task-specific PPE. For activities not covered by Table 6-1, SSO/CHSO will revise the hazard assessment and select the PPE using the information provided in Appendix F.

6.1 PPE Abbreviations

HEAD PROTECTION	EYE/FACE PROTECTION	FOOT PROTECTION
HH = Hard Hat HEARING PROTECTION EP = ear plugs EM = ear muffs	APR = Full Face Air Purifying Respirator with HEPA filter and organic vapor cartridge MFS = Mesh Face shield PFS =Plastic Face shield SG = ANSI approved safety glasses with side shields	Neo = Neoprene OB = Overboot Poly = Polyethylene coated boot Rub = Rubber slush boots STB = Leather work boots with steel toe

HAND PROTECTION	BODY PROTECTION	RESPIRATORY PROTECTION
Cot = cotton But = Butyl LWG = Leather Work Gloves Neo = Neoprene Nit = Nitrile Sur = Surgical Nit Sur - Nitrile Surgical	Cot Cov = Cotton Coveralls Poly = Polyethylene coated Tyvek coveralls Saran = Saranex coated Tyvek coveralls Tyvek = Uncoated paper Tyvek coveralls WC = Work clothes	Level D = No respiratory protection required Level C = Full face air purifying respirator with approved cartridges Level B = Full face air supplied respirator with escape bottle

TABLE 6-1

PERSONAL PROTECTIVE EQUIPMENT SELECTION

TASK	HEAD	EYE/FACE	FEET	HANDS	BODY	HEARING	RESPIRATOR
Mobilization/Demobilization							
Mobilization/ demobilization of equipment and supplies	HH as needed	SG as needed	STB	LWG as needed	WC	EP as needed	Level D
Establishment of site security, work zones and staging area	HH as needed	SG as needed	STB	LWG as needed	WC	EP as needed	Level D
Locate all utilities to and from the site	HH as needed	SG as needed	STB	LWG as needed	WC	EP as needed	Level D
Locate all active utility lines on site	HH as needed	SG as needed	STB	LWG as needed	WC	EP as needed	Level D
Investigation Activities							
Surface Soil Sampling	HH as needed	SG	STB, OB as needed	Nit	WC	EP as needed	Level D
Test Pit Installation and Sampling	HH	SG	STB, OB as needed	Nit	WC	EP	Level D initially, Level C-If action levels exceeded (see Section 8.0 of HASP)
Subsurface Soil Boring and Monitoring Well Installation and Sampling	HH	SG	STB, OB as needed	Nit	WC, Poly as needed	EP	Level D initially, Level C-If action levels exceeded (see Section 8.0 of HASP)
Sediment Boring and Sample Handling and Collection	HH	SG, PFS	STB, OB	Nit, Kev as needed	WC, PFD, Poly	EP as needed	Level C (P100 disposable respirator)
Survey	HH as needed	SG as needed	STB	LWG as needed	WC	EP as needed	Level D
Monitoring Well Development	HH as needed	SG as needed	STB	Nit	WC	EP as needed	Level D

TASK	HEAD	EYE/FACE	FEET	HANDS	BODY	HEARING	RESPIRATOR
Groundwater Sampling	HH as needed	SG	STB, OB as needed	Nit	WC, Poly as needed	EP as needed	Level D
Waste Handling	HH	SG	STB, OB as needed	LWG and Nit as needed	WC, Poly as needed	EP as needed	Level D initially, Level C-If action levels exceeded (see Section 8.0 of HASP)

7.0 MEDICAL SURVEILLANCE

All personnel performing field work where potential exposure to contaminants exists at the site are required to have passed a complete medical surveillance examination in accordance with 29 CFR 1910.120(f) and, where applicable, expanded health standards.

7.1 Medical Surveillance Requirements

A physician's medical release for work will be confirmed by the SSO before a worker can enter the exclusion zone. The examination will be taken annually at a minimum and upon termination of hazardous waste site work if the last examination was not taken within the previous six months. Additional medical testing may be required by the CHSO in consultation with the SSO if an over-exposure or accident occurs, if an employee exhibits symptoms of exposure, or if other site conditions warrant further medical surveillance.

8.0 MONITORING

Monitoring shall be performed to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of worker protection needed on site.

The Consultant conducts perimeter air monitoring, and work zone monitoring for Consultant employees. The Consultant will monitor and document daily site conditions and operations on National Grid's behalf.

The Contractor is responsible for the health and safety of Contractor and Subcontractor employees, and conducts work zone monitoring for Contractor and Subcontractor workers.

The CONTRACTOR is required to provide the following equipment for health and safety monitoring of its personnel:

- PID, or FID,
- Particulate Meter (PM-10 capable)
- Multiple gas Meter with Combustible Gas Indicator (CGI)/Oxygen (O2) / H2S / HCN sensors
- Drager Chip Measurement System (or equivalent instrument)
- Sound Level Meter if deemed necessary by the SSO and CHSO (type to be appropriate to the activities performed)

The Consultant and Contractor will adopt the air monitoring action levels and contingency plan presented within the Table 8-1 below. In the event that a Contractor has a more stringent action level requirement than the HASP, the Contractor will notify National Grid and the Consultant SSO and the CHSO to rectify the action level discrepancy.

The perimeter air monitoring will be conducted to conform with the community air monitoring plan (CAMP) guidelines presented by the New York State Department of Health in Appendix 1A of the Draft New York State Department of Conservation DER-10 Technical Guidance for Site Investigation and Remediation.

Total VOCs, hydrogen cyanide, hydrogen sulfide, oxygen, respirable particulate matter, dust, and odor will be monitored during all intrusive activities in accordance with the CAMP. Table 8-1 provides a summary of real time air monitoring action levels and contingency plans for work zone activities.

TABLE 8-1: Work Zone Air Monitoring Action Levels

Air Monitoring Instrument	Monitoring Location	Action Level	Site Action
PID/FID	Breathing Zone	0.5 ppm	Use detector tube for benzene or Znose™ to verify if concentration is benzene.
PID/FID	Breathing Zone	0 - 10 ppm	No respiratory protection is required
		10 - 250 ppm	Stop work, withdrawal from work area, institute engineering controls, if levels persist Upgrade to Level C
		> 250 ppm	Stop work, withdraw from work area; notify SSO & CHSO
Oxygen meter	Breathing Zone	< 20.7%	Stop work; withdraw from work area; ventilate area, notify SSO & CHSO.
		>21.1%	Stop work; withdraw from work area; notify SSO & CHSO.
H2S meter	Breathing Zone	<5 ppm	No respiratory protection is required
		>5 ppm	Stop work, cover excavation, withdraw from work area, institute engineering controls, notify SSO & CHSO
HCN meter	Breathing Zone	<1.0 ppm	Run CMS Drager tube, continue monitoring with real time meter; continue work if CMS Drager Tube Reading is less than 2ppm.
		1.0< HCN Conc<2.0 ppm	Run CMS Drager tube and confirm concentration is less than 2.0 ppm, notify SSO and CHSO. Run CMS drager tube for sulfur dioxide, hydrogen sulfide, and phosphine chip potential interferences. Continue to monitor with real time meter.
		>2.0 ppm	Stop work, and move (with continuous HCN monitoring meter) at least 25 ppm upwind of the excavation until continuous meter reads less than 1 ppm, Notify SSO & CHSO Run CMS Drager hydrogen cyanide chip and re-evaluate activity, continue monitoring with a real time meter, resume work if concentrations read less than 1.0 ppm.
CGI	Excavation/ Work Zone	< 10 % LEL	Investigate possible causes, allow excavation to ventilate; use caution during procedures.
		> 10% LEL	Stop work; allow excavation, borehole to ventilate to < 10% LEL; if ventilation does not result in a decrease to < 10% LEL, withdraw from work area; notify SSO & CHSO.
Particulate Meter [Subsurface Soil Investigation only]	Excavation/ Work Zone	0.150 ug/m^3	Implement work practices to reduce/minimize airborne dust generation, e.g., spray/misting of soil with water

Hydrogen cyanide can be present as iron complex compounds that do not generate hydrogen cyanide gas. As a matter of conservative policy, National Grid has instructed GEI and subcontractors to monitor for the presence of hydrogen cyanide gas as a precaution.

Carry cellular telephones for communication in a designated area away from subsurface investigation and sampling activities. Cellular phone use will not be permitted in the Exclusion Zone while work is being conducted in Level C PPE.

During sediment boring and handling operations PM100 respirators must be worn to address potential presence of airborne pathogens.

9.0 SITE CONTROL MEASURES

9.1 Site Zones

Site zones are intended to control the potential spread of contamination and to assure that only authorized individuals are permitted into potentially hazardous areas. A three-zone approach will be utilized. It shall include an Exclusion Zone (EZ), Contamination Reduction Zone (CRZ) and a Support Zone (SZ). Specific zones shall be established on the work site when operations begin for each task requiring such delineation (i.e. drilling, construction, excavation, trenching in impacted areas of the site). Maps depicting the zones will be available at the Site.

This project is being conducted under the requirements of 29 CFR 1910.120, and any personnel working in an area where the potential for exposure to site contaminants exists, will only be allowed access after proper training and medical documentation as required by National Grid. These records are maintained by the CHSO, and copies are provided to the SSO prior to mobilization for project activities.

The following shall be used for guidance in revising these preliminary zone designations, if necessary.

Support Zone - The SZ is an uncontaminated area that will be the field support area for most operations. The SZ provides for field team communications and staging for medical emergency. Appropriate sanitary facilities and safety equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged/decontaminated and labeled samples.

Contamination Reduction Zone - The CRZ is established between the EZ and the SZ. The CRZ contains the contamination reduction corridor and provides an area for decontamination of personnel and portable hand-held equipment, tools and heavy equipment. A personnel decontamination area will be prepared at each exclusion zone. The CRZ will be used for Exclusion Zone entry and egress in addition to access for heavy equipment and emergency support services.

Exclusion Zone - All activities which may involve exposure to site contaminants, hazardous materials and/or conditions should be considered an exclusion zone. This zone will be clearly delineated by cones, tapes or other means. The SSO may establish more than one EZ where different levels of protection may be employed or different hazards exist. The size of the EZ shall be determined by the site SSO allowing adequate space for the activity to be completed, field members and emergency equipment.

9.2 Communications

The following communications equipment shall be specified as appropriate:

- Telephones - A cellular telephone will be located in the SZ for communication with emergency support services/facilities and the home office. Personnel in the EZ can carry cellular telephones for communication as well if Level D PPE has been determined to be appropriate. Cellular phones will not be permitted in the EZ if work is being conducted in Level C PPE.
- Hand Signals - Hand signals shall be used by field teams along with the buddy system. They shall be known by the entire field team before operations commence and their use covered during site-specific training. Typical hand signals are the following:

Signal	Meaning
Grip on a partner's wrist or placement of both hands around a partner's waist	Leave area immediately, no debate
Hands on top of head	Need assistance
Thumbs up	Okay, I'm all right, I understand.
Thumbs down	No, negative.

10.0 DECONTAMINATION

PPE help prevent the wearer from becoming contaminated or inhaling contaminants, and good work practices help reduce contamination on protective clothing, instruments, and equipment. Even with these safeguards, contamination may occur. Harmful materials can be transferred to clean areas, exposing unprotected personnel. To prevent such occurrences, the following contamination reduction and decontamination procedures have been developed.

10.1 Minimization of Contact With Contaminants

During completion of all site activities, personnel should attempt to minimize the degree of contact with contaminated materials. This involves a conscientious effort to keep "clean" during site activities. All personnel should minimize kneeling, splash generation, and other physical contact with contamination. This may ultimately minimize the degree of decontamination required and the generation of waste materials from site operations.

10.2 Personnel Decontamination

Personnel hygiene, coupled with diligent decontamination, will significantly reduce the potential for exposure. Consideration will be given to prevailing wind directions so that the decontamination line, the support zone, and contamination reduction zone exit is upwind from the exclusion zone and the first station of the decontamination line. Decontamination will be performed by removing all PPE used in EZ and placing in drums/trash cans at CRZ. Disinfecting hand wipes shall be available for wiping hands and face. For Level D Decontamination, personnel should wash and rinse gloves, and wash and rinse hands and face with potable water. For Level C Decontamination, personnel should wash and rinse gloves and overboots, remove boot covers, remove outer gloves, remove Poly-coated suit, wash inner gloves, remove respirator, rinse inner gloves, remove inner gloves and wash and rinse hands and face.

10.3 Emergency Decontamination

If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination, wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or transporting equipment. If the injured person can be moved, he/she will be moved to the exclusion zone boundary and decontaminated by site personnel as described above before emergency responders handle the victim. If the person cannot be moved because of the extent of the injury (a back or neck injury) provisions shall be made to ensure that emergency response personnel will be able to respond to victim without being exposed to potentially hazardous atmospheric conditions. The only time an injured person should be removed is if the worker’s life is threatened to a greater degree than if he/she is left in the spot where the accident occurred. If emergency response personnel have to enter hazardous conditions to respond to victim

this should communicated when the emergency call is made and responders can come prepared in appropriate PPE. If the potential for inhalation hazards exist, such as with an open excavation, this area will be covered with plastic sheeting, or similar controls, to eliminate any potential inhalation hazards. All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent chemical data.

10.4 Hand Held Equipment Decontamination

Hand held equipment includes all monitoring instruments, samples, hand tools, and notebooks. The hand held equipment is dropped at the first decontamination station to be decontaminated by one of the decontamination team members. These items must be decontaminated or discarded as waste prior to removal from the exclusion zone.

To aid in decontamination, monitoring instruments can be sealed in plastic bags or wrapped in polyethylene. This will also protect the instruments against contaminants. The instruments will be wiped clean using wipes or paper towels if contamination is visually evident.

Decontamination procedures for sampling equipment, hand tools, etc., shall include the use of steam cleaning or a detergent wash, as appropriate for the site conditions.

10.5 Heavy Equipment Decontamination

Decontamination of chemically contaminated heavy equipment will be accomplished using high -pressure steam or dry decontaminated with brushes and shovels. Decontamination shall take place on a decontamination pad and all liquids used in the decontamination procedure will be collected. Vehicles or equipment brought into an exclusion zone will be treated as contaminated, and will be decontaminated prior to removal. All liquids used in the decontamination procedure will be collected, stored and disposed of in accordance with federal, state and local regulations. Personnel performing this task will wear the proper PPE as prescribed in Table 6-1.

11.0 EMERGENCY RESPONSE PLAN

This section establishes procedures and provides information for use during a project emergency. Emergencies happen unexpectedly and quickly, and require an immediate response; therefore, contingency planning and advanced training of staff are essential. Specific elements of emergency support procedures which are addressed in the following subsections include communications, local emergency support units, preparation for medical emergencies, first aid for injuries incurred on-site, record keeping, and emergency site evacuation procedures.

11.1 Pre-emergency Planning

Before the field activities begin, the local emergency response personnel may be notified by National Grid of the schedule for field activities and about the materials that are thought to exist on the site so that they will be able to respond quickly and effectively in the event of a fire, explosion, or other emergency.

In order to be able to deal with any emergency that might occur during remedial activities at the Site, emergency telephone numbers will be readily available in the SSO vehicle or construction office. These telephone numbers are presented in Appendix A. Hospital route maps will also be readily available in the SSO vehicle and/or Construction Office, and are also located in Appendix B.

11.2 Roles and Responsibilities

11.2.1 Corporate Health and Safety Officer (CHSO)

The CHSO oversees and approves the Emergency Response Plan and performs audits to determine that the plan is in effect and that all pre-emergency requirements are met. The CHSO acts as a liaison to applicable regulatory agencies and notifies OSHA of reportable accidents.

11.2.2 Site Safety Officer (SSO)

The SSO is responsible for ensuring that all personnel are evacuated safely and that machinery and processes are shut down or stabilized in the event of a stop work order or evacuation. The SSO is required to immediately notify the Consultant and National Grid Project Managers, and CHSO of any fatalities or injuries requiring more than basic first aid treatment. The CHSO will notify OSHA within the required time frame if a reportable incident has occurred. The CHSO will be notified of all OSHA recordable injuries, fires, spills, releases or equipment damage in excess of $500 within 24 hours.

The SSO also serves as the Emergency Coordinator. In the event of an emergency, the Emergency Coordinator, with National Grid representatives, shall make contact with Local Emergency Response personnel. In these contacts, the Emergency Coordinator

will inform response personnel about the nature of work on the Site, the type of contaminants and associated health or safety effects, and the nature of the emergency, particularly if it is related to exposure to contaminants.

The Emergency Coordinator shall review this plan and verify emergency phone numbers, identify hospital routes, and shall ensure the appropriate emergency equipment is available and in working order prior to beginning work on Site.

The Emergency Coordinator shall implement the Emergency Response Plan whenever conditions at the Site warrant such action.

11.2.3 Site Personnel

Site personnel are responsible for knowing the Emergency Response Plan and the procedures contained herein. Personnel are expected to notify the Emergency Coordinator of situations that could constitute a Site emergency.

11.3 Evacuation Routes and Procedures

All project personnel will be instructed on proper emergency response procedures and locations of emergency telephone numbers during the initial site safety meeting. If an emergency occurs at the work area, including but not limited to fire, explosion or significant release of toxic gas into the atmosphere, immediate evacuation of all personnel is necessary due to an immediate or impending danger. All heavy equipment will be shut down and all personnel will evacuate the work areas and assemble at a pre-determined location.

11.4 Contingency Plans

11.4.1 Fire Prevention and Protection

In the event of a fire or explosion, procedures will include immediately evacuating the work area. The Emergency Coordinator will immediately notify the local fire and police departments. No personnel will fight a fire beyond the stage where it can be put out with a portable extinguisher (incipient stage).

Fires will be prevented by adhering to the following precautions:

- Good housekeeping and storage of materials
- Storage of flammable liquids and gases away from oxidizers
- No smoking in the exclusion zone or any work area
- No hot work without a properly executed hot work permit
- Shutting off engines to refuel
- Grounding and bonding metal containers during transfer of flammable liquids
- Use of UL approved flammable storage cans

- Fire extinguishers rated at least 10 pounds ABC located on all heavy equipment, in all trailers and near all hot work activities
- Monthly inspections of all fire extinguishers.

The SSO is responsible for the maintenance of fire prevention and/or control equipment. The SSO is responsible for the control of fuel source hazards.

11.4.2 Overt Chemical Exposure

The following are standard procedures to treat chemical exposures. Other, specific procedures detailed on the MSDS will be followed as necessary. If first aid or emergency medical treatment is necessary the Emergency Coordinator will contact the appropriate emergency facilities.

SKIN AND EYE CONTACT:	Use copious amounts of soap and water. Wash/rinse affected areas thoroughly, then provide appropriate medical attention. Eyes should be rinsed for 15 minutes upon chemical contamination. Skin should also be rinsed for 15 minutes if contact with caustics, acids or hydrogen peroxide occurs. Transport to hospital or local medical provider.
INHALATION:	Move to fresh air. Decontaminate. Transport to hospital or local medical provider.
INGESTION:	Decontaminate and transport to emergency medical facility.
PUNCTURE WOUND OR LACERATION:	Decontaminate and transport to emergency medical facility.

11.4.3 Decontamination During Medical Emergencies

If emergency life-saving first aid and/or medical treatment is required, normal decontamination procedures may need to be abbreviated or postponed. The SSO or designee will accompany contaminated victims to the medical facility to advise on matters involving decontamination, when necessary. The outer garments can be removed if they do not cause delays, interfere with treatment or aggravate the problem. Respiratory equipment must always be removed. Protective clothing can be cut away. If the outer contaminated garments cannot be safely removed on site, a plastic barrier between the injured individual and clean surfaces should be used to help prevent contamination of the inside of ambulances and/or medical personnel. Outer garments may then be removed at the medical facility. No attempt will be made to wash or rinse the victim if his/her injuries are life threatening, unless it is known that the individual has been contaminated with an extremely toxic or corrosive material which could also cause severe injury or loss of life to emergency response personnel. For minor medical problems or injuries, the normal decontamination procedures will be followed.

11.4.4 Severe Weather

Barge Operations

The contingency plan for severe weather includes reviewing the expected weather to determine if severe weather is in the forecast. Severe weather includes high winds over 30 mph, heavy rains or snow squalls, thunderstorms, hurricanes, lightning storms, or wave action that makes drilling or boating unsafe. If severe weather is approaching, the decision to return to a pier or secure location at the shore of the canal will be made in a manner as to allow adequate time for the barge to return and all personnel to evacuate. The location where the barge will dock is to be determined by its location in the canal and the severity of the weather. The person in command of the vessel will make the final decision regarding movement of the barge. All equipment will be lashed securely to the deck of the barge and all personnel will evacuate the barge to a place of safety. The vessel captain will make the final decision for actions taken due to changing weather conditions.

Site Operations

In the event of adverse weather conditions, the SSO will determine if work can continue without potentially risking the safety of all field workers. Some of the items to be considered prior to determining if work should continue are:

- Potential for heat stress and heat-related injuries
- Potential for cold stress and cold-related injuries
- Treacherous weather-related working conditions (hail, rain, snow, ice, high winds)
- Limited visibility (fog)
- Potential for electrical storms
- Earthquakes
- Other major incidents

Site activities will be limited to daylight hours, or when suitable artificial light is provided, and acceptable weather conditions prevail. The SSO will determine the need to cease field operations or observe daily weather reports and evacuate, if necessary, in case of severe inclement weather conditions.

11.4.5 Sinking

If the barge begins to sink, all personnel shall abandon the barge and move into the support boat. Lines connecting the barge and support boats will be untied after evacuation to prevent the barge from dragging down the support boat.

11.4.6 Spill Control and Response

All small hazardous spills/environmental releases shall be contained as close to the source as possible. Whenever possible, the MSDS will be consulted to assist in determining the best means of containment and cleanup. For small spills, absorbent

materials such as sand, sawdust or commercial sorbents should be placed directly on the substance to contain the spill and aid recovery. Any acid or caustic spills should be diluted or neutralized carefully prior to attempting recovery. Berms of earthen or sorbent materials can be used to contain the leading edge of the spills. Drains or drainage areas should be blocked. All spill containment materials will be properly disposed. An exclusion zone of 50-100 feet around the spill area should be established depending on the size and type of the spill.

The Emergency Coordinator should take the following steps:

1. Determine the nature, identity and amounts of major spill components
2. Make sure all unnecessary persons are removed from the spill area
3. Notify appropriate response teams and authorities
4. Use proper PPE in consultation with the SSO and information provided on the MSDS for the spilled material
5. If a flammable liquid, gas or vapor is involved, remove all ignition sources and use non-sparking and/or explosive proof equipment to contain or clean up the spill (diesel only vehicles, air operated pumps, etc.)
6. If possible, try to stop the leak with appropriate material
7. Remove all surrounding materials that can react or compound with the spill
8. Notify the National Grid Project Manager.
9. Notify the PM and the CHSO.

11.5 Emergency Contact Information

Emergency Phone List
Greenpoint Energy Center Site

Medical Emergencies

Emergency Medical Services (NYC Fire Department)

Emergency	911
All other communications	311

Nearest Emergency Room (Brooklyn Hospital Center) 718-250-8000
121 Dekalb Ave, Brooklyn, NY 11201

Fire and Rescue Emergencies

Emergency	911
All other communications	311

Police Emergencies

NYC Police Department (94th Precinct 100 Meserole Avenue)

Emergency	911
All other communications	311
Switchboard	(718) 383-3879

Utility Emergencies	
Electric (Con Edison)	(800) 752-6633
Water/Sewer (NYC Dept of Environmental Protection)	(718) 699-9811
Natural Gas (National Grid)	(718) 643-4050
National Grid Site Contacts	
To Be Determined	
Underground Utilities (New York City One Call Center)	(800) 272-4480
Spill Incident	
New York State Department of Environmental Conservation	(800)-457-7362
National Response Center	(800) 424-8802
National Information Centers	
Chemtrec	(800) 424-9300
Poison Control Center	(800) 222-1222

11.6 Emergency Equipment

The following minimum emergency equipment shall be kept and maintained on-site.

- Industrial first aid kit
- Portable eye washes
- Fire extinguishers (one per vehicle and heavy equipment)
- Absorbent material
- Blood borne pathogen kit

11.7 Postings

The following information shall be posted or be readily visible and available at conspicuous locations throughout the site:

- Emergency telephone numbers
- Hospital Route Map

11.8 Restoration and Salvage

After an emergency, prompt restoration of utilities, fire protection equipment, medical supplies and other equipment will reduce the possibility of further losses. Some of the items that may need to be addressed are:

- Refilling fire extinguishers;
- Refilling medical supplies;
- Recharging eyewashes and/or showers

- Replenishing spill control supplies
- Replacing used air horns

12.0 LOGS, REPORTS, AND RECORD KEEPING

The following is a summary of required health and safety logs, reports, and record keeping. The SSO will maintain an on-site file for all the following logs, reports, and records. The CHSO or designee will maintain a parallel file off-site.

12.1 Medical and Training Records

Copies or verification of training (40 hour, 8 hour, supervisor, and site-specific training) and medical clearance for hazardous waste site work and respirator use will be maintained by the CHSO and copies provided to the SSO prior to the initiation of work on-site.

12.2 On-Site Log

A log of personnel on-site each day will be kept by the SSO in a field logbook.

12.3 Exposure Records

All personal monitoring results, laboratory reports, calculations and air sampling data sheets will be maintained by the SSO during site work. At the end of the project they may be maintained in employee files if deemed necessary by the CHSO.

12.4 Accident/Incident Reports

The incident reporting and investigation during site work will follow the Incident Reporting Program in Appendix J.

12.5 OSHA Form 300

An OSHA Form 300 will be maintained at the Contractor or Consultant home office. The SSO may retain a copy of the OSHA Form 300 on-site. All recordable injuries or illnesses will be recorded on this form. The incident report form referenced in Appendix J meets the requirements of the OSHA Form 101(supplemental record) and must be maintained with the OSHA Form 300 for all recordable injuries or illnesses.

12.6 Hazard Communication Program/MSDS

MSDSs will be obtained for applicable substances and included in the site hazard communication file. The hazard communication program will be maintained onsite in accordance with 29 CFR 1910.1200 and the Hazard Communication Program in Appendix D.

12.7 Work Permits

All work permits, including confined space entry, hot work, lockout/tagout, and line-breaking permits will be maintained in the project files. Copies of the work permits shall also be provided to the SSO, and the National Grid Project Manager.

13.0 FIELD PERSONNEL REVIEW

This form serves as documentation that field personnel have read, or have been informed of, and understand the provisions of this HASP for the Greenpoint Energy Center. It is maintained on-site by the SSO as a project record. Each field team member shall sign this section after training on the contents of this HASP has been completed. Site workers must sign this form after site-specific training is completed and before being permitted to work on site.

I have read, or have been informed of, the Health and Safety Plan and understand the information presented. I have also completed site-specific training for the work detailed in the project Work Plan. I will comply with the provisions contained therein.

NAME (PRINT AND SIGN)	DATE

APPENDIX A

ORGANIZATIONAL STRUCTURE / CONTACT INFORMATION

National Grid
Contact Information

Name	Title	Contact Information
Tracy Bell	Manager	Office: 718-963-5645 Mobile: 917-886-9207 E-mail: tracey.bell@us.ngrid.com
Donald Campbell	Project Manager	Office: 718-963-5453 Mobile: 973-715-8447 E-mail: donald.campbell@us.ngrid.com
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

GEI Consultants, Inc.
Project Team Contact Information

Name	Title	Contact Information
Michael D. Zukauskas, P.E.	Project Manager	Office: (973) 509-9650 Mobile: (908) 458-3230 E-mail: MZukauskas@geiconsultants.com
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
Robin DeHate	Corporate Health and Safety Officer (CHSO)	Office: (813) 654-8055 Mobile: (813) 323-6220 E-mail: RDeHate@geiconsultants.com
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Boring Subcontractor 1
Contact Information

Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Boring Subcontractor 2
Contact Information

Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Boring Subcontractor 3
Contact Information

Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Test Pit Subcontractor
Contact Information

Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Survey Subcontractor
Contact Information

Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Utility Survey Subcontractor
Contact Information

Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Specialty Subcontractor 1
Contact Information

Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Specialty Subcontractor 2
Contact Information

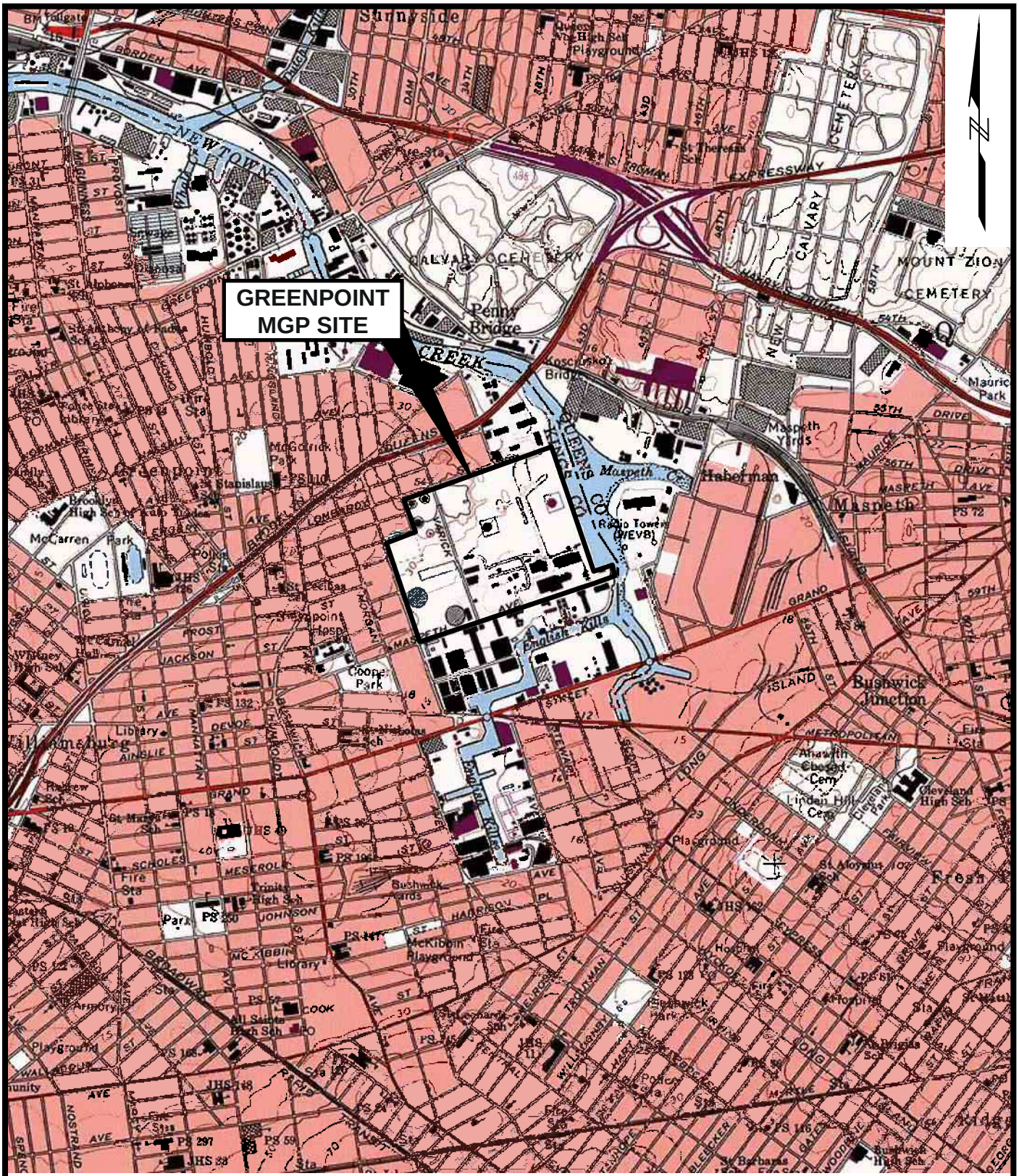
Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

Specialty Subcontractor 3
Contact Information

Name	Title	Contact Information
	Project Manager	Office: Mobile: E-mail:
	Field Team Leader/Site Safety Officer (SSO)	Office: Mobile: E-mail:
	Corporate Environmental Safety Manager (CESM)	Office: Mobile: E-mail:
		Office: Mobile: E-mail:
		Office: Mobile: E-mail:

APPENDIX B

SITE-SPECIFIC INFORMATION


GREENPOINT
MGP SITE
N
Sunnyside
NEWTOWN CREEK
Penny Bridge
CALVARY CEMETERY
MOUNT ZION CEMETERY
Maspeth
Haberman
Bushwick Junction
Bushwick Houses
McCarren Park
Cooper Park
Playground
Greenpoint Hosp.
Brooklyn High School
Trinity High Sch
Cleveland High Sch
Fresh
Maspeth Creek
Maspeth Yards
Radio Towers (WEVD)
Calvary Cem
Mount Zion Cem
Linden Hill Cem
Evergreen Cem
Bushwick Houses
Playground
Playground
Playground

Google Maps

Start **Maspeth Ave**
Maspeth, NY 11378

End **121 Dekalb Ave, Brooklyn, NY 11201**

Travel **4.8 mi – about 15 mins**

Figure 2: Directions to The Brooklyn Hospital Center
Phone: 718-250-8000

Maspeth Ave
Maspeth, NY 11378

Drive: 4.8 mi – about 15 mins

1.	Head **west** on **Maspeth Ave** toward **Vandervoort Ave**	0.5 mi 1 min
2.	Turn **left** at **Vandervoort Ave**	0.2 mi 1 min
3.	Turn **right** at **Grand St**	0.4 mi 1 min
4.	Turn **left** at **Bushwick Ave**	0.7 mi 3 mins
5.	Turn **right** at **Flushing Ave**	0.9 mi 3 mins
6.	Turn **left** at **Nostrand Ave**	0.6 mi 2 mins
7.	Turn **right** at **DeKalb Ave**	1.4 mi 4 mins

121 Dekalb Ave, Brooklyn, NY 11201

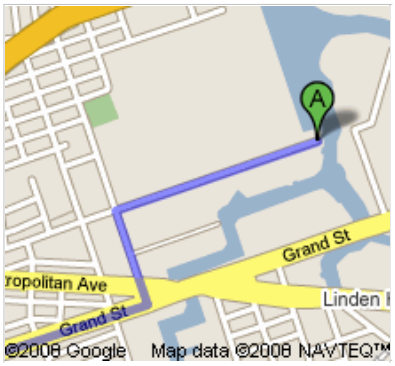
These directions are for planning purposes only. You may find that construction projects, traffic, or other events may cause road conditions to differ from the map results.

Map data ©2008 NAVTEQ™, Sanborn

Overview



Start



End



Map data ©2008 NAVTEQ™, Sanborn

APPENDIX C

PROJECT SPECIFIC ACTIVITY HAZARD ANALYSIS

WORK TASK	POTENTIAL HAZARDS	CONTROLS
Activity: Pre-Investigation and Utility Clearance		
Site Mobilization/Activity	Biological Hazards.	Proper clothes, body inspections, insect repellant.
	Slip, Trip, Fall Hazards	Identify and repair potential tripping hazards. Maintain safe and orderly work areas.
	Traffic Hazards	Use traffic cones, signage, and traffic safety vests in accordance with New York City Traffic Regulations. Use a traffic spotter.
	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Noise	Distancing form noise, hearing protection
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
Protective Equipment: Flotation vest when on boat and when boarding/debarking. Hard hat, safety glasses, and leather work gloves as needed.		
Activity: Test Pit Installation and Sample Collection		
Test Pit Installation and Sample Collection	Heavy Equipment / Proximity to Heavy Equipment	Distancing, safe work practices, inspections, wear hearing protection.
	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.
	Noise	Distancing form noise, hearing protection
	Traffic Hazards	Use traffic cones, signage, and traffic safety vests in accordance with New York City Traffic Regulations. Use a traffic spotter.
	Tool Use	Use proper guarding, inspections, wear safety glasses with side shields, hearing protection.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
	Contaminant Contact	Wear protective coveralls (e.g., Tyvek®) (if needed) with shoe covers, nitrile gloves, and safety glasses when handling samples. Dispose of gloves after sampling. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated soils	Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide and hydrogen cyanide), and dust monitor to monitor the work zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist, then upgrade to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of the HASP. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the RI Work Plan and Appendix K of this HASP.
Protective Equipment: Hardhat, steel-toe boots, safety glasses, hearing protection, and nitrile gloves.		
Activity: Subsurface Boring/Monitoring Well Installation and Sample Collection		
Subsurface Boring/ Monitoring Well Installation and Sample Collection	Heavy Equipment / Proximity to Heavy Equipment	Distancing, safe work practices, inspections, wear hearing protection.
	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.
	Noise	Distancing form noise, hearing protection

WORK TASK	POTENTIAL HAZARDS	CONTROLS
	Traffic Hazards	Use traffic cones, signage, and traffic safety vests in accordance with New York City Traffic Regulations. Use a traffic spotter.
	Tool Use	Use proper guarding, inspections, wear safety glasses with side shields, hearing protection.
	Contaminant Contact	Wear protective coveralls (e.g., Tyvek®) (if needed) with shoe covers, nitrile gloves, and safety glasses when handling samples. Dispose of gloves after sampling. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated soils	Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide and hydrogen cyanide), and dust monitor to monitor the work zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist, then upgrade to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of the HASP. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the RI Work Plan and Appendix K of this HASP.
Protective Equipment: Hardhat, steel-toe boots, safety glasses, hearing protection, and nitrile gloves.		
Activity: Surface Soil Sample Collection		
	Contaminant Contact	Wear nitrile gloves, and safety glasses when installing points. Dispose of gloves after installation. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
	Exposure to vapors from contaminated soils	Use work zone air monitoring equipment including photoionization detector. If air monitoring action levels are exceeded, then engineering controls will be implemented.
Protective Equipment: Steel-toe boots, safety glasses, and nitrile gloves. Hardhat as needed.		
Activity: Soil Vapor Point Installation and Sampling		
Soil Vapor Point Installation and Sampling	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.
	Noise	Distancing form noise, hearing protection
	Tool Use	Use proper guarding, inspections, wear safety glasses with side shields, hearing protection.
	Contaminant Contact	Wear nitrile gloves, and safety glasses when installing points. Dispose of gloves after installation. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated soils	Use work zone air monitoring equipment including photoionization detector. If air monitoring action levels are exceeded, then engineering controls will be implemented.
Protective Equipment: Steel-toe boots, safety glasses, and nitrile gloves. Hardhat as needed.		
Activity: Hydraulic Conductivity Testing		
Hydraulic Conductivity Testing	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
	Contaminant Contact	Wear nitrile gloves when sampling points. Dispose of gloves after installation. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.
	Exposure to vapors from contaminated groundwater	Use work zone air monitoring equipment including photo-ionization detector. If air monitoring action levels are exceeded, then engineering controls will be implemented.
Protective Equipment: Steel-toe boots, safety glasses, and nitrile gloves. Hardhat as needed.		
Activity: Survey		
Survey	Adverse Weather	Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.
	Heat/Cold Stress	Acclimatization, work/rest regimes, drinking warm/cold fluids.
	Slip/Trip/Fall	Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.
	Traffic Hazards	Use traffic cones, signage, and traffic safety vests as needed.
Protective Equipment: Steel-toe boots. Hardhat and safety glasses as needed.		
Activity: Sediment Boring and Surface Water Sample Collection		
Moving barge to exploration locations; set up barge to sample by lowering anchors.	Interaction with other boat traffic. Drowning.	Wear PFD. Follow USGC Safe Boating Practices. Radio for communications

WORK TASK	POTENTIAL HAZARDS	CONTROLS
Advancing borings and sampling.	Subsurface hazards (utilities especially).	Review available utility plans and evaluate geophysical survey data obtained during bathymetry survey. Visually confirm clearance from known utilities.
	Contact with equipment, especially moving parts. Overhead hazard (rods).	Stay alert and maintain suitable clearance from moving and overhead equipment. Do not wear loose clothing, jewelry, or equipment, which could get caught by moving equipment. Inspect equipment daily. Train all personnel on use of emergency shutoff switches.
	Weather related equipment hazards (slippage in rain, lightning).	Cease operations prior to and during electrical storms. Cease operations if equipment cannot be operated safely under wet conditions.
	Slip/trip/fall.	Keep trafficked areas on boat or barge free of slip/trip/fall hazards.
	Drowning.	Wear PFD.
	Loud noise (outboard motor, generator, VC sampler).	Use hearing protection during the operation of equipment that produces loud noise.
	Contact with contaminated surface water or sediments.	Wear P100 disposable respirator and protective coveralls (e.g. Tyvek®) with shoe covers, nitrile gloves, safety glasses and face shield when handling samples. Dispose of gloves after sampling. Wash hands. If exposed, immediately wash exposed skin with antibacterial wipes and antibacterial gel.

WORK TASK	POTENTIAL HAZARDS	CONTROLS
Lift and secure anchors. Relocate to next exploration location.		Wear P100 disposable respirator and nitrile gloves during sediment handling manipulation. Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide, and hydrogen cyanide) to monitor the works zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist then change to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of this HASP.
Protective Equipment: Flotation vest when on boat and when boarding/debarking . Hardhat, safety glasses, P100 disposable respirator, steel toe boots, protective coveralls (e.g. Tyvek®), and nitrile gloves.		

APPENDIX D

HAZARD COMMUNICATION PROGRAM

1.0 POLICY AND PURPOSE

It is the policy of the Consultant to furnish employees with a working environment safe from recognized hazards. This program is designed to provide the Consultant compliance with OSHA's Federal Hazard Communication Standard (29 CFR 1910.1200 and 1926.59).

The Consultant Hazard Communication (HAZCOM) Program has been compiled to provide guidelines for assisting this corporation in meeting the requirements of OSHA's Hazard Communication Standard. This program addresses the evaluation of potential Consultant workplace hazards and communication of pertinent hazard information to Consultant employees.

The **CONTRACTOR** must develop a HAZCOM for **CONTRACTOR** employees and **SUBCONTRACTORs**.

Although most **CONTRACTOR** field projects do not involve the use of hazardous substances, it is imperative that all hazardous materials be managed in accordance with this program. This applies to any usage of hazardous materials regardless of volume. The Contractor shall generate a list of chemicals that are anticipated to be used during work activities.

2.0 SCOPE

In accordance with 29 CFR 1910.1200 and 1926.59, this program applies to any potentially hazardous chemical which is known to be present in the workplace in such a manner that employees may potentially be exposed under normal conditions of use. This program also addresses chemicals that may be constituents of waste that may be encountered on a typical Consultant job site.

3.0 LOCATION OF WRITTEN PROGRAM

A complete original of this written program is located with the Consultant Corporate Health and Safety Officer (CHSO) and with each Consultant Office/Branch Manager.

4.0 RESPONSIBILITIES

Overall coordination and implementation of Consultant HAZCOM Program is the responsibility of the CHSO. Any questions, comments, or suggestions relating to Consultant HAZCOM Program should be directed to the CHSO.

The following subsections delineate the responsibilities of personnel as required for successful implementation of this program.

Corporate Health and Safety Officer (CHSO)

The CHSO shall:

- Develop and oversee implementation of the written HAZCOM Program
- At a minimum, determine that field personnel engaged in hazardous waste operations receive OSHA 40-hour Health and Safety Training, 24-hour supervised on-the-job training, 8-hour Supervisory Training, and annual 8-hour Retraining as required by OSHA (29 CFR 1910.120 and 29 CFR 1926.65)

Office/Branch Managers

The Office/Branch Managers shall:

- Determine that all new employees at their office/branch receive training in accordance with the HAZCOM Program within 30 days of hire or prior to performing field work (whichever is sooner)
- Maintain at the office/branch an inventory of Material Safety Data Sheets (MSDSs) as available for all hazardous materials with which employees have the potential of coming into contact while on the job
- Determine that MSDSs are made readily available for employee review upon request by the employee
- Determine that label and warning protocol for hazardous materials is complied with

Supervisors (Project Mangers and/or Field Team Leaders)

Supervisors shall:

- Develop and oversee completeness of site-specific HASPs for their projects
- Implement the hazard communication programs and HASPs for their projects
- Determine that field personnel are familiar with the HAZCOM Program regarding chemical use and potential chemical exposures in the field
- Determine that employees working on their project sites are familiar with site-specific HASPs and perform in compliance with the requirements of those HASPs.

Employee

It is the employee's responsibility to:

- Read the HAZCOM procedure within 30 days of employment by the Consultant or prior to performing field work for CONSULTANT (whichever is sooner)
- Gain familiarization with MSDSs of those hazardous materials which they use or may be exposed to
- Utilize information and measures as learned from the HAZCOM Program, including associated training and professional experiences, to protect themselves from adverse exposure to hazardous materials

5.0 PROGRAM REQUIREMENTS

Material Safety Data Sheets (MSDSs) and Chemical List

Complete sets of MSDSs for chemicals specific to each office/branch are maintained by the Consultant Office/Branch Manager and made readily available for review upon request by any employee.

A list of chemicals potentially used/encountered by Consultant personnel at offices/branches involved in hazardous waste operations is provided in Table 11-1. Note that Table 11-1 is not necessarily complete.

MSDSs are available for the listed chemicals described below.

- MSDSs for chemicals that are typically used for decontamination and/or sample preservation are compiled. Supplies of these chemicals are generally kept in Consultant field equipment storerooms.
- MSDSs for chemicals and materials that may be encountered on typical Consultant job sites are compiled. These MSDSs are typically included in site-specific Health and Safety Plans. MSDSs should be reviewed prior to performing fieldwork on those sites.
- MSDSs for chemicals used for PID soil gas instrument and standards are compiled. These chemicals are generally kept in small quantities to be used only by soil gas instrument technical personnel.

In addition, the consultant maintains an a comprehensive collection of MSDSs as printed by Genium Publishing Corporation and as obtained from manufacturers of products received at Consultants office are available for use by employees by request to the CHSO. This MSDS collection is updated periodically.

TABLE 11-1
CHEMICAL LIST
DECONTAMINATION AND/OR PRESERVATION CHEMICALS (Field/Storeroom Personnel)

Chemical	*Amount Stored	Location
Acetone	20 liters	Field Equipment Room Flammable Storage Cabinet
Acetonitrile	4 liters	Field Equipment Room Flammable Storage Cabinet
1-Butanol (n-Butyl Alcohol)	0.5 liter	Field Equipment Room Flammable Storage Cabinet
Hexane	20 liters	Field Equipment Room Flammable Storage Cabinet
Hydrochloric Acid	0.5 liter	Field Equipment Room Corrosive Storage Cabinet
Methanol	40 liters	Field Equipment Room Flammable Storage Cabinet
Nitric Acid	15 liters	Field Equipment Room Corrosive Storage Cabinet
Sodium Hydroxide	1 kg	Field Equipment Room Corrosive Storage Cabinet (separated from acids)
Sulfuric Acid	0.5 liter	Field Equipment Room Corrosive Storage Cabinet

* Amounts stored are based on typical field equipment room inventory (Glastonbury Office). Actual amounts may vary depending on facility location and project requirements.

CHEMICALS POTENTIALLY ENCOUNTERED ON TYPICAL JOB SITES

Chemical
Benzene
Coal Tar Creosote
Coal Tar Pitch
Cresol
Cyanide
1,1-Dichloroethylene
1,2-Dichloroethylene (both isomers)
Ethylbenzene
Gasoline
Naphtha (Coal Tar)
Naphthalene and related PAHs
Pentrachlorophenol
Perchloroethylene
Polychlorinated Biphenyls
Styrene
1,1,2,2-Tetrachloroethane
Tetraethyl Lead
Toluene
1,1,1-Trichloroethane (methyl chloroform)
Trichloroethylene
Xylene

LABELS AND WARNINGS

The Consultant labeling system for containers of hazardous materials is as follows:

- Containers are labeled, tagged, or marked in a legible fashion, with the identity of the hazardous materials contained therein.
- Containers are labeled, tagged, or marked in a legible fashion with the appropriate hazard warnings. This warning may be of any type of message, words, pictures or symbols that convey the hazards of the chemical.
- All required container labels, tags and/or markings are legible.
- Labels are affixed to the container itself (vs. lid). Note that lids may also be labeled, but not in lieu of container labeling.

The Consultant field equipment room maintenance technician is responsible that the Consultant labeling system is complied with at his/her office location. Project Managers and Field Team Leaders are responsible for determining that the Consultant labeling system is complied with for the field portion of their projects.

TRAINING

The Consultant Office/Branch Manager is responsible for determining that the HAZCOM Training Program is complied with by personnel employed at their office/branch.

The Consultant's HAZCOM Program training requirements are listed below:

- Newly hired employees who may use or be exposed to hazardous materials will be required to familiarize themselves with the HAZCOM Program, and with the MSDSs associated with their job function.
- Selected employees will be required to attend a HAZCOM Program classroom training session. Training shall provide information on:

    - The physical and health hazards of the chemicals in the work area
    - Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area
    - Measures employees can take to protect themselves from these hazards
    - The details of the HAZCOM Program, including an explanation of MSDSs and CONSULTANTs container labeling system

- As required to achieve compliance with OSHA 1910.120 and 1926.65, technical staff engaged in hazardous waste operations will be provided with OSHA 40-hour HAZWOPER safety training, 24 hours of on-the-job training, and annual 8-hour HAZWOPER refresher courses.

6.0 MULTI-EMPLOYER WORK PLACES

The Consultant is obligated to provide the identity of any hazardous materials/conditions to other employers sharing the same workplace whose employees may be exposed. Likewise, all employers sharing the same workplace with the Consultant shall be obligated to identify all hazardous materials/conditions to which employees may be exposed. The employer sharing space with the Consultant will be required by the Consultant Project Manager to:

- Determine that a mutual exchange of this information occurs, and that health and safety hazards are minimized
- Provide to project employees, as part of the subcontractor HASP, MSDSs of identified hazardous materials to which they may be exposed
- Conform in full to the requirements of 29 CFR 1910.1200 and 29 CFR 1926.59, applicable HASPs, and established work procedures

These obligations may be accomplished via the exchange of written HAZCOM Programs, project HASPs, or MSDSs as appropriate.

7.0 BIENNIAL REVIEW

This program will be formally reviewed by the Consultant CHSO and company management on a biennial basis or more frequently if the CHSO deems it necessary to promote personnel safety. The program will be revised as necessary for continuing compliance with the OSHA Federal Hazard Communication Standard.

APPENDIX E

COLD STRESS PROGRAM

1.0 PURPOSE & INTRODUCTION

The purpose of this document is to educate the employee about exposure to cold environments and the effects of hypothermia and other cold-related injuries. Through proper use of Personal Protective Equipment (PPE), engineering and administrative controls; and education, cold injury, both to the extremities and the body's core temperature, can be prevented.

2.0 SCOPE

This program is intended for use by employees engaged in work with the potential for exposure to cold environments. This program will be reviewed annually by the Health and Safety Division. Training will be provided annually to all those potentially affected, and will include this written program.

3.0 WORKING IN COLD ENVIRONMENTS

1. Metabolic Responses

The human body is designed to function best at a rectal temperature of 99-100F. The body maintains this temperature in two ways: by gaining heat from food and muscular work; or, by losing it through radiation and sweating. By constricting blood vessels of the skin and/or shivering, the body uses its first line of cold defense.

Temperature control of the body is better understood by dividing the body into two main parts: the shell; and, the core. The shell is comprised of the skin, capillaries, nerves, muscles and fat. Other internal organs such as the heart, lungs, brain and kidneys make up the core.

During exposure to cold, the skin is first affected. Blood in the peripheral capillaries is cooled, sending a signal to a portion of the brain called the hypothalamus. Regulating body temperature is one of the many basic body functions of the hypothalamus. Acting like a thermostat, adjustments are performed in order to maintain normal body temperatures. When a chill signal is received, two processes are begun by the hypothalamus: conserve heat already in the body; and, generate new heat.

Heat conservation is performed through constriction of the blood vessels in the skin (shell), thus reducing heat loss from the shell and acting as an insulator for the core. Sweat glands are also inhibited, thus preventing heat loss by evaporation.

Additional fuel for the body is provided in the form of glucose. Glucose causes the heart to beat faster, sending oxygen and glucose-rich blood to the tissue where needed. In an attempt to produce heat, the muscles rapidly contract. This process is better known as “shivering”, and generates heat similarly to that created by strenuous activity, raising the body’s metabolic rate.

During physical activity and fatigue, the body is more prone to heat loss. As exhaustion approaches, blood vessels can suddenly enlarge, resulting in rapid loss of heat. Exposure to extreme cold causes nerve pulses to be slowed, resulting in fumbling, sluggish and clumsy reactions.

4.0 COLD INJURIES

Cold injuries are classified into two categories: local; or, general. Local injuries include frostbite, frostnip, chilblain and trenchfoot. General injuries include hypothermia and blood vessel abnormalities (genetically or chemically induced). Major factors contributing to cold injury are exposure to humidity and high winds; contact with wetness or metal; inadequate clothing; age; and, general health. Allergies, vascular disease, excessive smoking and/or drinking, and certain drugs and medicines are physical conditions that can compound the effects of exposure to a cold environment.

1. Hypothermia

Hypothermia is a condition of reduced body temperature. Most cases develop in air temperatures between 30-50°F, not taking wind-chill factor in consideration.

Symptoms of hypothermia are uncontrolled shivering and the sensation of cold. The heartbeat slows and sometimes becomes irregular, weakening the pulse and changing blood pressure. Changes in the body chemistry cause severe shaking or rigid muscles; vague or slow slurred speech; memory lapses; incoherence; and, drowsiness. Cool skin, slow irregular breathing, low blood pressure, apparent exhaustion, and fatigue after rest can be seen before complete collapse.

As the core temperature drops, the victim can become listless, confused, and make little or no effort to keep warm. Pain in the extremities can be the first warning of dangerous exposure to cold. Severe shivering must be taken as a sign of danger. At a core body temperature of about 85°F, serious problems develop due to significant drops in blood pressure, pulse rate and respiration. In some cases, the victim may die.

Sedative drugs and alcohol increase the risk of hypothermia. Sedative drugs interfere with the transmission of impulses to the brain. Alcohol dilates blood vessels near the skin's surface, increasing heat loss and lowering body temperature.

Table I provides information on the onset of hypothermia and metabolic responses at different body temperatures.

2. Raynaud's Phenomenon

Raynaud's Phenomenon is the abnormal constriction of the blood vessels of the fingers on exposure to cold temperatures, resulting in blanching of the ends of the fingers. Numbness, itching, tingling or a burning sensation may occur during related attacks. The disease is also associated with the use of vibrating hand tools in a condition sometimes called White Finger Disease. Persistent cold sensitivity, ulceration and amputations can occur in severe cases.

3. Acrocyanosis

Acrocyanosis is caused by exposure to the cold and reduces the level of hemoglobin in the blood, resulting in a slightly blue, purple or gray coloring of the hands and/or feet.

4. Frostbite

Frostbite is the freezing of the body tissues due to exposure to extremely low temperatures, resulting in damage to and loss of tissue. Frostbite occurs because of inadequate circulation and/or insulation, resulting in freezing of fluids around the cells of the body tissues. Most vulnerable parts of the body are the nose, cheeks, ears, fingers and toes.

Frostbite can affect outer layers of skin or can include the tissues beneath. Damage can be serious, with permanent loss of movement in the affected parts, scarring, necrotic tissue, and amputation are all possibilities. Skin and nails that slough off can grow back.

The freezing point of the skin is about 30F. As wind velocity increases, heat loss is greater and frostbite will set in more rapidly.

There are three (3) degrees of frostbite: first degree, freezing without blistering and peeling; second degree, freezing with blistering and peeling; and, third degree, freezing with death of skin tissues and possibly the deeper tissues.

The following are symptoms of frostbite:

a. Skin changes color to white or grayish-yellow, progresses to reddish-violet, and finally turns black as the tissue dies;

b. Pain may be felt at first, but subsides;

c. Blisters may appear;

d. Affected part is cold and numb.

The first symptom of frostbite is usually an uncomfortable sensation of coldness followed by numbness. Tingling, stinging, cramping and aching feelings will be experienced by the victim. Frostbite of the outer layer of the skin has a waxy or whitish look and is firm to the touch. Cases of deep frostbite cause severe injury. The tissues are cold, pale and solid. The victim is often unaware of the frostbite until someone else observes these symptoms. It is therefore important to use the "buddy system" when working in cold environments, so that any symptoms of overexposure can be noted.

Table II describes the cooling power of wind on exposed flesh. This information can be used as a guide for determining equivalent chill temperatures when the wind is present in cold environments.

5. Trench Foot and Chilblains

Trench foot is swelling of the foot caused by long, continuous exposure to cold without freezing, combined with persistent dampness or immersion in water. Edema (swelling), tingling, itching and severe pain occurs, followed by blistering, necrotic tissue and ulcerations. Chilblains have similar symptoms as trench foot, except that other areas of the body are affected.

6. Frostnip

Frostnip occurs when the face or extremities are exposed to a cold wind, causing the skin to turn white.

5.0 PREVENTION OF COLD STRESS

Cold Stress can be prevented through a combination of various factors: acclimation; water and salt displacement; medical screening, proper clothing selection; and, training and education. Through the use of engineering controls, work practices, work/rest schedules, environmental monitoring and consideration of the wind-chill temperature, the employee can be protected.

1. Acclimatization

Acclimation can be achieved to some degree. Sufficient exposure to cold causes the body to undergo changes to increase comfort and reduce the risk of injury. But, these changes are minor and require repeated exposure to cold and uncomfortable temperatures to induce them.

2. Dehydration

The dryness of cold air causes the body to lose a significant amount of water through the skin and lungs. It is essential that caffeine-free, non-alcoholic beverages be available at the worksite for fluid replacement. Dehydration also increases the risk of injury due to cold and affects blood flow to the extremities.

3. Diet

A well-balanced diet is important for employees working in cold environments. Diets restricted only to certain foods may not provide the necessary elements for the body to withstand cold stress, leaving the worker vulnerable.

4. Control Measures

When the wind-chill factor results in an equivalent temperature of -26^{o}F, continuous exposure of the skin will not be permitted. Any worker exposed to temperatures of 36^{o}F or less, who becomes immersed in water, will be given dry clothing immediately and treated for hypothermia at the local hospital if any symptoms of hyperthermia are present. Notification of this incident will be provided to the Health and Safety Division immediately after sending the worker to the hospital.

5. Engineering Controls

The following are some ways that environmental controls can be used to reduce the effects of a cold environment:

a. General or spot heating should be used to increase temperature in certain areas in the workplace;

b. Warm air jets, radiant heaters or contact warm plates can be used to warm the worker's hands if fine work is to be performed with bare hands for 10 to 20 minutes or more;

c. Shield the work area if air velocity at the work site is increased by wind, draft or ventilating equipment;

d. Metal handles of tools and control bars should be covered with thermal insulating material at temperatures below 30F;

e. Unprotected metal chair seats will not be used in cold environments;

f. When appropriate and feasible, equipment and processes will be substituted, isolated, relocated, or redesigned;

g. Power tools, hoists, cranes or lifting aids will be used to reduce the metabolic workload;

h. Heated warming shelters will be made available for continuous work being performed in an equivalent temperature of 20F or below. Workers will be encouraged to use the shelters regularly.

6. Administrative Work Practice Controls

Work practices and guidelines can be designed and developed to reduce exposure to cold stress. Some of these may include:

a. Work-rest schedules to reduce the peak of cold stress;

b. Enforce scheduled breaks;

c. Enforce intake of warm caffeine-free, non-alcoholic beverages;

d. Schedule work that has potential exposure to cold stress for the warmest part of the day;

e. Move work to warmer areas, whenever possible;

f. Assign extra workers for high-demand tasks;

g. Provide relief workers for other workers needing breaks;

h. Teach basic principles of recognizing and preventing cold stress;

i. Use the buddy system for work at 10F or below, and keep within eyeshot;

j. Allow new employees to adjust to the conditions before they work full-time in cold environments;

k. Minimize sitting and standing in one place for long periods of time;

l. Include weight and bulkiness of clothing when estimating work performance requirements and weights to be lifted;

Table III provides a work/warm-up schedule for cold environments, with wind chill taken into account.

7. Special Considerations

Older workers and workers with circulatory problems should be extra careful in cold environments. Sufficient sleep and good nutrition are important preventive measures for maintenance tolerance to the cold. Double shifts and overtime work should be avoided when working in cold environments.

If any of the following symptoms are observed on site, the affected worker will immediately go to warm shelter:

- Onset of heavy shivering;
- Frostnip;
- Feeling of excessive fatigue;
- Drowsiness;
- Euphoria.

After entering the warm shelter, the outer layer of clothing should be removed. If the clothing is wet from sweat and perspiration, dry clothing should be provided. If this is not feasible, then the clothing should be loosened to allow sweat to evaporate.

Anyone working in cold environments and on prescribed medication should consult their physician concerning any possible side effects due to cold stress. Those individuals suffering from diseases and/or taking medication that interferes with normal body temperature regulation or reduces the tolerance to cold will not be allowed to work in temperatures of 30F or below.

6.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

In choosing PPE for cold environments, it is important to maintain airspace between the body and outer layer of clothing to retain body heat. The more air pockets, the better the insulation. The clothing should also allow for the evaporation of sweat if the skin is wet.

The most important parts of the body to protect are the feet, hands, head and face. Hands and feet become cooled most easily, because of their distance from the heart. Keeping the head covered is equally important. As much as 40% of body heat loss is through the head when it is exposed.

Ideal clothing for exposure to cold environments is made of cotton. Cotton picks up sweat off the body and brings it to the surface. Loosely fitted clothing also aids in sweat evaporation. Recommended clothing may include the following:

a. Polypropylene under shirt and shorts under thermal underwear (preferably two-piece);

b. Wool socks;

c. Wool or thermal pants, lapped over boot tops to keep out snow and water;

d. Suspenders (belts can constrict and reduce circulation);

e. Insulated work boots, preferably waterproof. Safety toe, if necessary;

f. Wool or cotton shirt;

g. Parka;

h. Knit cap/hard hat liner;

i. Wool mittens or gloves (depending on the dexterity required);

j. Face mask or scarf.

Dirty or greasy clothing loses much of its insulation value. Dirty clothing crushes air pockets, allowing air to escape more easily. Also, denim is not a good protective fabric. It is loosely woven and allows water to penetrate and wind to blow away body heat.

TABLE I
Progressive Clinical Presentation of Hypothermia*

Core Temperature Deg. C	Deg. F	Clinical Signs
37.6	99.6	"Normal" rectal temperature.
37	98.6	"Normal" oral temperature.
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss.
35	95.0	Maximum shivering.
34	93.2	Victim conscious and responsive, with normal blood pressure.
33	91.4	Severe hypothermia below this temperature.
32	89.6	Consciousness clouded; blood pressure becomes difficult to obtain;
31	87.8	pupils dilated but react to light; shivering ceases.
30	86.0	Progressive loss of consciousness; muscular rigidity increases;
29	84.2	pulse and blood pressure difficult to obtain; respiratory rate decreases.
28	82.4	Ventricular fibrillation possible with myocardial irritability.
27	80.6	Voluntary motion ceases; pupils non-reactive to light; deep tendon and superficial reflexes absent.
26	78.8	Victim seldom conscious.
25	77.0	Ventricular fibrillation may occur spontaneously.
24	75.2	Pulmonary edema.
22	71.6	Maximum risk of ventricular fibrillation.
20	68.0	Cardiac standstill.
18	64.4	Lowest accidental hypothermia victim to recover.
17	62.6	Isoelectric electroencephalogram.
9	48.2	Lowest artificially cooled hypothermia patient to recover.

* Presentations approximately related to core temperature. Reprinted from the January 1982 issue of American Family Physician, published by the American Academy of Family Physicians.

TABLE II

Cooling Power of Wind on Exposed Flesh as Equivalent Temperature (under calm conditions)*

Estimated Wind Speed (mph)	**Actual Temperature Reading (Degrees Fahrenheit)**											
	50	**40**	**30**	**20**	**10**	**0**	**-10**	**-20**	**-30**	**-40**	**-50**	**-60**
	Equivalent Chill Temperature (☐F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect).	LITTLE DANGER In < hr with dry skin. Maximum danger of false sense of security.				INCREASING DANGER Danger from freezing of exposed flesh within one minute.			GREAT DANGER Flesh may freeze within 30 seconds.				
	Trenchfoot and immersion foot may occur at any point on this chart.											

* Developed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA

Note #1: Wind speeds greater than 40 mph have little additional effect.

Note #2: Trenchfoot and immersion foot may occur at any point on this chart

TABLE III
Threshold Limit Values Work/Warm-up Schedule for 4 Hour Shift (*)

<table>
<tr><th colspan="2">Air Temp.-Sunny Sky</th><th colspan="2">No Noticeable Wind</th><th colspan="2">5 mph Wind</th><th colspan="2">10 mph Wind</th><th colspan="2">15 mph Wind</th><th colspan="2">20 mph Wind</th></tr>
<tr><th>˚C (approx)</th><th>˚F (approx)</th><th>Max. Work Period</th><th>No. of Breaks</th><th>Max. Work Period</th><th>No. of Breaks</th><th>Max. Work Period</th><th>No. of Breaks</th><th>Max. Work Period</th><th>No. of Breaks</th><th>Max. Work Period</th><th>No. of Breaks</th></tr>
<tr><td>-26˚ to -28˚</td><td>-15˚ to -19˚</td><td colspan="2">(Norm. Breaks) 1</td><td colspan="2">(Norm.Breaks) 1</td><td>75 min.</td><td>2</td><td>55 min.</td><td>3</td><td>40 min.</td><td>4</td></tr>
<tr><td>-29˚ to -31˚</td><td>-20˚ to -24˚</td><td colspan="2">(Norm. Breaks) 1</td><td>75 min</td><td>2</td><td>55 min.</td><td>3</td><td>40 min.</td><td>4</td><td>30 min.</td><td>5</td></tr>
<tr><td>-32˚ to -34˚</td><td>-25˚ to -29˚</td><td>75 min</td><td>2</td><td>55 min.</td><td>3</td><td>40 min.</td><td>4</td><td>30 min.</td><td>5</td><td colspan="2" rowspan="5">Non-emergency work should cease</td></tr>
<tr><td>-35˚ to -37˚</td><td>-30˚ to -34˚</td><td>55 min.</td><td>3</td><td>40 min.</td><td>4</td><td>30 min.</td><td>5</td><td colspan="2" rowspan="4">Non-emergency work should cease</td></tr>
<tr><td>-38˚ to -39˚</td><td>-35˚ to -39˚</td><td>40 min.</td><td>4</td><td>30 min.</td><td>5</td><td colspan="2" rowspan="3">Non-emergency work should cease</td></tr>
<tr><td>-40˚ to -42˚</td><td>-40˚ to -44˚</td><td>30 min.</td><td>5</td><td colspan="2" rowspan="2">Non-emergency work should cease</td></tr>
<tr><td>-43˚ & below</td><td>-45˚ & below</td><td colspan="2">Non-emergency work should cease</td></tr>
</table>

Notes for TABLE III:

1. Schedule applies to moderate to heavy work activity with warm-up breaks of 10 minutes in a warm location. For light to moderate work (limited physical motion), apply the schedule one step lower. For example, at -30F with no noticeable wind (step 4, a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4 hour period.

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph, light flag moves; 10 mph, light flag fully extended; 15 mph, raises newspaper sheet; 20 mph, blowing drifting snow.

3. If only the wind-chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind-chill cooling rate of about 17 W/m2; 2) all non-emergency work should have ceased at or before a wind-chill of 2250 W/m2. In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart over-compensates for the actual temperatures in the colder ranges, since windy conditions prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

* Adapted from Occupational Health and Safety Division, Saskatchewan Department of Labor.

APPENDIX F

HEAT STRESS PROGRAM

1.0 INTRODUCTION

Heat stress is one of the most common (and potentially serious) illnesses at job sites. Although it is caused by a number of interacting factors, the wearing of PPE puts the worker at a much higher risk during warmer environmental conditions. The results of heat stress range from fatigue to serious illness or death. Through regular fluid replacement and other preventive measures, heat stress can be controlled, leading to increased efficiency and a higher level of safety on the job.

2.0 PURPOSE

To create an awareness among employees concerning the body's physiologic responses to heat; different types of heat stress that can affect the body; recognition of signs and symptoms; first aid treatment; and, preventive measures.

3.0 SOURCES OF HEAT

There are two sources of heat that are important to anyone working in a hot environment:

- Internally generated metabolic heat;
- Externally imposed environmental heat.

4.0 PHYSIOLOGIC RESPONSES TO HEAT

The human body maintains a fairly constant internal temperature, even though it is exposed to varying environmental temperatures. To keep internal body temperatures within safe limits, the body must get rid of its excess heat, primarily through varying the rate and amount of blood circulation through the skin and the release of fluid onto the skin by the sweat glands. These automatic responses usually occur when the temperature of the blood exceeds 98.6°F and are kept in balance and controlled by the brain. In this process of lowering internal body temperature, the heart begins to pump more blood, blood vessels expand to accommodate the increased flow, and the microscopic blood vessels (capillaries) which thread through the upper layers of the skin begin to fill with blood. The blood circulates closer to the surface of the skin, and the excess heat is lost to the cooler environment.

If the heat loss from increased blood circulation through the skin is not adequate, the brain continues to sense overheating and signals the sweat glands in the skin to release large quantities of sweat onto the skin surface. Evaporation of sweat cools the skin, eliminating large quantities of heat from the body.

As environmental temperatures approach normal skin temperature, cooling of the body becomes more difficult. If air temperature is as warm as or warmer than the skin, blood brought to the body surface cannot lose its heat. Under these conditions, the heart continues to pump blood to the body surface, the sweat gland pour liquids containing electrolytes onto the surface of the skin, and the evaporation of the sweat becomes the principal effective means of maintaining a constant body

temperature. Sweating does not cool the body unless the moisture is removed from the skin by evaporation. In high humidity, the evaporation of sweat from the skin is decreased and the body's efforts to maintain an acceptable body temperature may be significantly impaired. These conditions adversely affect an individual's ability to work in the hot environment. With so much blood going to the external surface of the body, relatively less goes to the active muscles, the brain, and other internal organs; strength declines; and fatigue occurs sooner than it would otherwise. Alertness and mental capacity also may be affected. Workers who must perform delicate or detailed work may find their accuracy suffering, and others may find their comprehension and retention of information lowered.

When temperature differences exist between two or more bodies, heat can be transferred. Net heat transfer is always from the body (or object) of higher temperature to that of lower temperature and occurs by one or more of the following mechanisms:

Conduction. The transfer of heat from one point to another within the body, or from one body to another when both bodies are in physical contact. Conduction can be a localized source of discomfort from direct physical contact with a hot or cold surface, it is normally not a significant factor to total heat stress.

Convection. The transfer of heat from one place to another by moving gas or liquid. Natural convection results from differences in density caused by temperature differences. Thus warm air is less dense than cool air.

Radiation. The process by which energy, electromagnetic (visible and infrared), is transmitted through space without the presence or movement of matter in or through this space.

5.0 PREDISPOSING FACTORS TO HEAT STRESS

Factors that may predispose an individual to heat stress vary according to the individual. These factors include:

- Lack of physical fitness;
- Lack of acclimatization;
- Age;
- Dehydration;
- Obesity;
- Drug/alcohol abuse;
- Infection;
- Sunburn;
- Diarrhea;
- Chronic disease.

Predisposing factors and an increased risk of excessive heat stress are both directly influenced by the type and amount of PPE worn. PPE adds weight and bulk, reduces the body's access to normal heat exchange mechanisms (evaporation, convection and radiation) and increases energy expenditure.

6.0 FORMS OF HEAT STRESS AND FIRST AID

(The following excerpts were taken from NIOSH Publication No. 86-112, Working in Hot Environments):

"Excessive exposure to a hot work environment can bring about a variety of heat-induced disorders. Among the most common are heat stroke, heat exhaustion, heat cramps, fainting and heat rash.

Heat Stroke

Heat Stroke is the most serious of health problems associated with working in hot environments. It occurs when the body's temperature regulatory system fails and sweating becomes inadequate. The body's only effective means of removing excess heat is compromised with little warning to the victim that a crisis stage has been reached.

A heat stroke victim's skin is hot, usually dry, red or spotted. Body temperature is usually 105°F or higher, and the victim is mentally confused, delirious perhaps in convulsions, or unconscious. Unless the victim receives quick and appropriate treatment, death can occur.

Individuals with signs or symptoms of heat stroke require immediate hospitalization. First aid should be immediately administered. This includes removing the victim to a cool area, thoroughly soaking the clothing with water, and vigorously fanning the body to increase cooling. Further treatment, at a medical facility, should be directed to the continuation of the cooling process and the monitoring of complications which often accompany heat stroke. Early recognition and treatment are the only means of preventing permanent brain damage or death.

Heat Exhaustion

Heat Exhaustion includes several clinical disorders having symptoms which may resemble the early symptoms of heat stroke. Heat exhaustion is caused by the loss of large amounts of fluid by sweating, sometimes with excessive loss of salt. A worker suffering from heat exhaustion still sweats but experiences weakness or fatigue, giddiness, nausea or headache. In more serious cases, the victim may vomit or lose consciousness. The skin is clammy and moist, the complexion is pale or flushed, and the body temperature is normal or only slightly elevated.

In most cases, treatment involves having the victim rest in a cool place and drink plenty of liquids. Victims with mild cases of heat exhaustion usually recover spontaneously with this treatment. Those with severe cases may require extended care for several days. There are no known permanent effects.

Heat Cramps

Heat cramps are painful spasms of the muscles that occur among those who sweat profusely in heat, drink large quantities of water, but do not adequately replace the body's salt loss. The drinking of large amounts of water tends to dilute the body's fluids, while the body continues to lose salt. Shortly after, the low salt level in the muscles causes painful cramps. The affected muscles may be part of the arms, legs, or abdomen; but tired muscles (those used in performing the work) are usually the ones most susceptible to cramps. Cramps may occur during or after work hours and may be relieved by taking salted liquids by mouth.

Fainting

Fainting occurs in workers not accustomed to hot environments and who stand erect and immobile in the heat.

With enlarged blood vessels in the skin and in the lower part of the body due to the body's attempts to control internal temperature, blood may pool there rather than return to the heart to be pumped to the brain. Upon lying down, the worker should soon recover. By moving around, and thereby preventing blood from pooling, the patient can prevent further fainting.

Heat Rash (Prickly Heat)

Heat rash, also known as prickly heat, is likely to occur in hot, humid environments where sweat is not as easily removed from the surface of the skin by evaporation and the skin remains wet most of the time. The sweat ducts become plugged, and a skin rash soon appears. When the rash is extensive or when it is complicated by infection, prickly heat can be very uncomfortable and may reduce a worker's performance. The worker can prevent this condition by resting in a cool place part of each day and by regularly bathing and drying the skin."

7.0 SELECTION OF PERSONAL PROTECTIVE EQUIPMENT (PPE)

During work periods where the increased risk of heat stress exists, each item's benefit will be carefully evaluated. Once the PPE is chosen, safe work durations/rest periods will be determined based on the following conditions:

- Anticipated work rate;
- Ambient temperature and humidity;
- Level of protection.

8.0 PREVENTION OF HEAT STRESS

Prevention of heat stress will be addressed in the following manner:

1. Adjustment of work schedules.

    a. Modify work/rest schedules.
    b. Enforce work slowdowns, as needed.
    c. Rotate personnel to minimize overstress or overexertion.
    d. When possible, work will be scheduled and performed during cooler hours.

1. Provide shelter or shaded areas to protect personnel during rest periods.

2. Maintain worker's body fluids at normal levels.

    a. Drink approximately 12 to 16 ounces of non-caffeinated liquid (preferably water, Gatorade or equivalent) prior to the start of work. Caffeinated fluids act to dehydrate the worker.

    b. Workers will be urged to drink a cup or two every 15 to 20 minutes, or at each break. A total of 1 to 1.5 gallons of water per individual per day are recommended for fluid replacement under heat stress conditions, but more may be required.

3. Encourage physical fitness among the workers.

    Gradually acclimatize workers on site to help build up an "immunity" to the conditions.

    - Heat acclimatization can usually be induced in 5 to 7 days of exposure at a hot job. For workers with previous experience with the job, acclimatization will include exposures of 50% for day 1, 60% for day 2, 80% for day 3, and 100% for the remaining additional days.

4. Provide cooling devices during prolonged work or severe heat exposure.

    a. Supply field showers or hose down areas.

    b. Supply personnel with cooling jackets, vests, and suits.

5. Train workers in recognition and treatment of heat stress.

6. Use of the buddy system that depends on the recognition of signs and symptoms of heat stress.

7. Identification of heat-intolerant individuals through medical screening.

APPENDIX G

PERSONAL PROTECTIVE EQUIPMENT (PPE) PROGRAM:

1.0 PURPOSE

This program has been developed to aide in the proper selection and use of PPE to protect workers from identified potential hazards. Careful selection and use of adequate PPE should protect the respiratory system, skin, eyes, face, hands, feet, head, body and hearing. **CONTRACTOR** employees may work at a variety of job sites and locations, which may require different types of protective equipment. Client specific requirements will always be adhered to. **CONTRACTOR** will supply all PPE or reimburse the employee for the costs of PPE if the PPE is required as part of the project.

2.0 SCOPE

This program establishes criteria for the selection, use, donning and doffing, inspection, maintenance, storage, decontamination of PPE, and evaluation. This information is general, and specific PPE use should be included in the site-specific health and safety plan prepared for each project.

3.0 OSHA REQUIREMENTS (29 CFR 1910.120)

A written personal protective equipment program, which is part of the employer's safety and health program and also part of the site-specific health and safety plan shall be established. The PPE program shall address the elements listed below.

- PPE selection based upon site hazards
- PPE use and limitations of the equipment
- Work mission duration
- PPE Maintenance and storage
- PPE decontamination and disposal
- PPE training and proper fitting
- PPE donning and doffing procedures
- PPE inspection procedures prior to, during and after use
- Evaluation of the effectiveness of the PPE program
- Limitations during temperature extremes, heat stress, and other appropriate medical considerations

OSHA Standard 29 CFR 1910.132 requires employers to assess the employer's workplace and determine if hazards are present that necessitate the use of personal protective equipment (PPE). This assessment must be certified in writing and documented.

Due to the variety of job sites and situations that **CONTRACTOR** personnel may be involved in, it is important that **CONTRACTOR** maintain a consistent approach in complying with health and safety procedures. The project manager and/or site supervisor are responsible for ensuring that all personnel wear the appropriate PPE. Failure to comply with these requirements may result in disciplinary action. Employee safety is a paramount concern for all **CONTRACTOR** managers and employees. These procedures will now require the following:

1. Protective footwear must be worn by all field personnel working in the field. Footwear must at a minimum include steel toe and shank protection. Additionally, chemical protective footwear may also be required if the potential for contaminated materials exists. This type of protection will be required on a site-specific basis.

2. Eye protection must be worn by all field personnel during all sampling activities, drilling and earth removal activities, stack sampling, and inside manufacturing facilities. Eye protection must include side shields. Prescription lenses worn as eye protection and other protective eyewear must meet ANSI Z87.1-1989.

3. Hardhats are to be worn by all field personnel when in the field. New hardhats must meet ANSI Z89-1986.

4. Hand protection is to be worn on a task-specific basis. The hand protection must be selected based on the chemical hazards expected to be encountered. **CONTRACTOR** maintains a stock of a variety of gloves including:

Best:	Nitrile N-Dey
	PVC
	Latex
	Vinyl
	Solvex, Nitrile
	Leather Work Gloves

Additionally, nitrile coated Kevlar gloves or other types of puncture resistant gloves are to be worn by all personnel working with or cleaning glass impingers. Manufacturers that supply these gloves include Ansell Edmont, Jomac and Wells Lamont. Insulated electrical gloves with outer leather gloves is required when working around high-voltage systems. **CONTRACTOR** is responsible for supplying all personal protective equipment required for **CONTRACTOR**'s projects.

4.0 WORK MISSION DURATION

Before donning any PPE ensembles, workers will estimate their anticipated work duration. There are several limiting factors that affect the length of work time. These factors must be addressed:

- Air supply consumption
- Breakthrough time on respirator cartridges.
- Available cartridge for the chemical for air purifying respirators
- Permeation and penetration of the Chemical Protective Clothing/ensemble;
- Ambient temperature; and
- Coolant supply (ice or chilled area to keep the worker's body temperature at a normal temperature).

No single combination of PPE is capable of protection against all hazards. Thus PPE must be used in conjunction with other protective methods and its effectiveness evaluated periodically.

The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress and impaired vision, mobility and communication. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. However, over-protection as well as under-protection can be hazardous and should be avoided when possible.

5.0 LEVEL OF PROTECTION

The following section describes the different levels of protection (A through D). Each level is described in the following manner: the protection provided; when this particular level of protection should be used; recommended and optional equipment; and, any limiting criteria. Combinations of PPE other than those described for Levels A, B, C and D protection may be more appropriate and may be used to provide the proper level of protection.

1. Level A

a. Protection provided:

- Level A provides the highest available level of respiratory, skin and eye protection.

b. Should be used when:

- The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on any of the following circumstances;

- Measured (or potential for) high concentration of atmospheric vapors, gases or particulates;

- Site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases or particulates of materials that are harmful to skin or capable of being absorbed through intact skin;

- Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible;

- The Operations must be conducted in confined, poorly ventilated areas until absence of conditions requiring Level A protection is determined.

c. Recommended equipment:

- Pressure-demand, full face piece SCBA or pressure-demand supplied-air respirator with escape SCBA;

- Fully-encapsulating, chemical-resistant suit (pressure-tested immediately before use);
- Inner chemical-resistant suit;

- Inner chemical-resistant gloves;

- Chemical-resistant safety boots/shoes; and

- Two-way radio communications.

d. Optional equipment:

- Cooling unit;
- Coveralls;
- Long cotton underwear;
- Hard hat; and
- Disposable gloves and boot covers.

e. Limiting criteria:

- Fully encapsulating suit material must be compatible with the substances involved.

2. Level B

a. Protection provided:

- The same level of respiratory protection, but less skin protection than Level A.

b. Should be used when:

- The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves atmospheres with IDLH concentrations of specific substances that do not represent a severe skin hazard, or that do not meet the criteria for use of air purifying respirators;

- Atmospheres contain less than 19.5% oxygen; and

- Presence of incompletely identified vapors or gases indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.

c. Recommended equipment:

- Pressure-demand, full face piece SCBA or pressure-demand supplied-air respirator with escape SCBA;

- Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit);

- Inner and outer chemical-resistant gloves;

- Chemical-resistant safety boots/shoes;

- Hard hat; and

- Two-way radio communications.

d. Optional equipment:

- Coveralls;
- Disposable boot covers;
- Face shield; and
- Long cotton underwear.

e. Limiting criteria:

- Use only when the vapors or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin.

- Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases or splashes of material that will affect the exposed skin.

3. Level C

a. Protection provided:

- Level C provides the same level of skin protection as Level B, but a lower level of respiratory protection.

b. Should be used when:

- The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin;

- The types of air contaminants have been identified, concentrations measured, and a canister/cartridge is available that can remove the contaminant; and

- All criteria for the use of air-purifying respirators are met.

c. Recommended equipment:

- Full face piece or half face piece air-purifying negative pressure respirator;
- Chemical-resistant clothing;
- Inner and outer chemical-resistant gloves;
- Chemical-resistant safety boots and shoes;
- Disposable boot covers;
- Hard hat; and
- Two-way radio communications.

d. Optional equipment:

- Coveralls;
- Face shield;
- Escape bottle; and
- Long cotton underwear.

e. Limiting criteria:

- Atmospheric concentration of chemicals must not exceed IDLH levels; and
- The atmosphere must contain at least 19.5% oxygen.

4. Level D

a. Protection provided:

- No respirator protection and minimal skin protection.

b. Should be used when:

- The atmosphere contains no known hazard; and

- Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

c. Recommended equipment:

- Coveralls;
- Safety boots/shoes;
- Safety glasses or chemical splash goggles; and
- Hardhat.

d. Optional equipment:

- Gloves;
- Face shield.

e. Limiting criteria:

- This level should not be worn in the exclusion zone; and
- The atmosphere must contain at least 19.5% oxygen.

6.0 LEVEL OF PROTECTION UTILIZED BY CONTRACTOR PERSONNEL

Due to the nature of our work, personnel will not perform any work that will require the use of Level A protection. Contractor will not directly undertake assignments and Contractor does not train or equip its personnel to handle circumstances involving Level A protection. If Contractor is working on a site and Level A is deemed necessary, the work will be subcontracted to a qualified firm. Contractor personnel should not directly undertake these tasks.

Sites where Contractor is working often require the use of Level C or D, with Level B equipment available on-site for emergency rescue if necessary. Any questions concerning the level of protection necessary to complete a certain task will be directed to the Corporate Environmental Safety Manager before setting up the job.

7.0 TYPES OF CONTRACTOR PPE

The following list contains all types of PPE that the **CONTRACTOR** has ready access to if required by site conditions or National Grid bid requirements for site activities.

1. Respiratory Equipment:

    a. SCBAs:

        - Used for emergency rescue and exposures greater than maximum use concentration limits set for canister/cartridge type negative pressure respirators.

    b. Supplied-air respirators:

        - MSA Premaire system.

    c. Negative pressure respirators:

        - Half face and full face, used for exposure to certain types of acid gases, organic vapors and particulates not greater than the canister/cartridge maximum use concentration limit.

2. Chemical protective apparel suits:

    a. Polycoated Tyvek, Saranex, Chemrel and Tyvek (porous). Provide protection against certain liquid chemicals.

        - Tyvek provides protection against particulates only.

    b. Fire/flame retardant coveralls:

- Provide protection against flash fires.

3. Insulated clothing (Provides protection against exposure to the cold:

   a. Chemical resistant gloves:

      - Provide protection for the hands against skin contact and skin absorption.

   b. Disposable boot covers:

      - Protect safety boots from contamination and feet from contact with chemicals.

4. Eye protection:

   a. Safety glasses and chemical splash goggles.

      - Safety glasses protect the eyes against large particles and projectiles.
      - Chemical splash goggles protect the eyes against vaporized chemicals, splashes, large particles, and projectiles.

   b. Vented goggles do not provide protection against vapors and are not adequate for splashes, as material may seep inside the goggles.

5. Hard hat:

   - Provides protection against blows to the head. When worn with a liner, provides protection against the cold.

6. Construction safety boots:

   - Steel-toe and shank construction boots with chemically resistant soles protect the feet from heavy and sharp objects, and contact with chemicals.

7. Safety harnesses and lifelines:

   - Enable the individual to work in elevated areas or enter confined spaces to prevent falls and aid in rescue.

8. Hearing protection:

   - Provides protection against physiological damage.

9. Canvas work gloves:

- Provide protection for the hands against abrasions and slivers.

8.0 SELECTION OF CHEMICALLY PROTECTIVE CLOTHING

1. Chemically-protective clothing (CPC) will be chosen in the following manner:

a. Determine what chemicals are present on the site.

b. CPC chosen must be resistant to permeation, degradation and penetration of the chemical(s).

- Permeation - Process by which a chemical dissolves in and/or moves through a protective clothing material on a molecular level.

- Degradation - The loss of or change in the fabric's chemical resistance or physical properties due to exposure to chemicals, use or ambient conditions (e.g., sunlight).

- Penetration - The movement of chemicals through zippers, stitched seams or imperfections (e.g., pinholes) in CPC.

c. Review manufacturer's permeation data to determine the performance characteristics of the material to the specific chemical. .

d. Select CPC that protects against the greatest range of chemicals on the site and has the longest breakthrough time.

e. Discuss choice of CPC with the project CHSO, PM, and SSO prior commencing work.

9.0 DONNING AND DOFFING PROCEDURES

The following procedures will be used by **CONTRACTOR** employees for donning and doffing PPE at protection Levels B and C. Donning and doffing will be performed with the assistance of an individual(s) located in the Support Zone and Contamination Reduction Zone, respectively. This individual will help the worker tape up and adjust PPE for proper fit, as well as remove PPE after decontamination.

1. Donning PPE

- Inspect the clothing and respirator before donning.
- Unzip the suit.
- Step into the legs of the suit, slipping the feet through the legs. Push arms through the sleeves.
- Pull leg cuffs over the feet.
- Put on chemical-resistant safety boots over the feet. Tape the leg cuff over the tops of the boots.
- Pull over chemical-resistant boot covers and tape over the leg cuff.
- If suit contains protective feet, wear chemical-resistant safety boots inside the suit with chemical-resistant boot covers over the suit and taped securely to the leg.
- If wearing a SCBA, don the face piece and adjust it to be secure, but comfortable. Do not connect the breathing hose. Open valve on the air tank.
- If wearing a negative pressure respirator, pull hood over the head and perform positive and negative pressure face piece seal test.
- Pull on chemical protective inner gloves.
- Pull on chemical protective outer gloves and tape securely to the sleeve of the suit.
- Securely tape the suit to protect all exposed skin around the neck area, and if wearing a full-face piece, tape around the edge of the hood-to-face piece junction.
- Put on hardhat, if needed, and tape securely on top of head so that the hard hat does not slide off.

2. Doffing PPE

- Doffing of PPE will not take place until the individual has been properly decontaminated by a suitably attired assistant. Both the worker and assistant will make every effort to avoid any direct contact with the outside of the suit.

- If the individual is wearing a SCBA, the hose connection to the diaphragm will be disconnected, leaving the face piece on the wearer. The remainder of the unit will be removed and decontaminated before proceeding further.

- If the individual is wearing a half-face or full-face negative pressure respirator, she/he will be instructed to leave it on until the doffing procedure is complete.

NOTE: Decontamination is to be performed in accordance with the Site-Specific Health and Safety Plan for the site.

10.0 DECONTAMINATION OF PPE

Whenever possible, disposable PPE will be used on-site. Disposable PPE includes the following:

- Chemical protective suits;
- Gloves; and
- Chemical protective boot covers.

After decontaminating the worker, PPE is disposed of on-site in labeled disposal containers.

11.0 INSPECTION OF PPE

PPE will be inspected prior to, during and after each use according to the procedure outlined below.

1. Prior to use (Reusable and Disposable PPE):

   a. Through reviewing available literature, determine that the clothing material is correct for the task.

   b. Visually inspect for:

      - Imperfect seams;
      - Non-uniform coatings;
      - Tears or holes; and
      - Malfunctioning closures.

c. Hold up to the light and check for pinholes (inflate gloves and check for leaks).

d. Flex and check for:

- Cracks; and
- Shelf deterioration.

e. If previously used, check for:

- Discoloration;
- Swelling;
- Stiffness and cracking; and
- Holes and tears.

2. During use (Reusable and Disposable PPE), check for:

a. Evidence of chemical attack.
b. Discoloration, swelling, stiffening, softening and/or cracking.
c. Tears.
d. Punctures.
e. Seam discontinuities.

Note: Report any sense of breakthrough to the Health and Safety Assessment Division. Medical monitoring may be necessary to determine the extent of exposure.

3. After use (Reusable PPE), check for:

a. Malfunctioning parts.
b. Evidence of chemical attack.
c. Punctures.
d. Tears.
e. Cracks.

12.0 MAINTENANCE AND STORAGE OF PPE

PPE, other than respiratory equipment, will be maintained and stored in accordance with the manufacturer's recommendations at a minimum to prevent damage due to exposure to dust, moisture, sunlight, chemicals, temperature extremes and sudden impact.

Employees are given Field Operations Equipment bags prior to working on any **CONTRACTOR** sites. PPE that is given to the individual solely for his/her use will be stored in this bag. Before and after each use, the PPE will be inspected to determine whether or not it is still “field worthy”. Any PPE found to be defective will be reported to the Health and Safety Assessment Division and either discarded or repaired, as appropriate. Under no circumstances will defective PPE be used in the field.

8. The SSO will periodically inspect PPE issued for individual use.

    a. Unless the equipment can be repaired, any PPE found to be defective will be removed from service and discarded immediately.

    b. Repairable PPE will be tagged, returned to the SSO and sent out for repair.

13.0 EVALUATION OF PPE PROGRAM

CONTRACTOR's Personal Protection Equipment Program will be reviewed annually by the CHSO. Any program deficiencies that are identified by a **CONTRACTOR** employee will be reported to the CHSO, so that changes will be made immediately. All employees affected by the change(s) will be notified in writing.

Review of the PPE Program will include, but not be limited to, the following:

- Accident and illness experience on various job sites.
- Type and degree of exposure.
- Adequacy of equipment selection process.
- Degree of fulfillment of program objectives.
- Employee acceptance.
- Coordination with overall health and safety program elements.
- Recommendations for program improvements and modifications.
- Adequacy of program records.

APPENDIX H

CONTROL OF HAZARDOUS ENERGY PROGRAM “LOCK OUT/TAG OUT”

1.0 INTRODUCTION

The Lock Out/Tag Out Standard, 29 CFR 1910.147, is prevents approximately 120 deaths and 60,000 injuries per year. Under this standard, **CONTRACTOR** is required to establish a program that utilizes procedures for locking out and/or tagging to isolate and disable the equipment to prevent accidental start-up or release of stored energy. **CONTRACTOR** employees will identify, locate and control these energy sources, as necessary.

DEFINITIONS

Affected Employee: An employee whose job requires operation/use of equipment or machines on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him/her to work in an area in which such servicing or maintenance is being performed. All **CONTRACTOR** personnel or subcontractors working in these circumstances are "affected employees".

Authorized Employee: A person who locks out or implements a tagout system procedure on machines or equipment in connection with the servicing or maintenance on that machine or equipment. An authorized person and an affected employee may be the same person when the affected employee's duties also include performing a lock out or tag out on a machine or equipment.

Capable of being Locked Out: An energy isolating device will be considered to be capable of being locked out either if it designed with a hasp or other attachment or integral part to which, or through which, a lock can be affixed, or if it has a locking mechanism built into it. Other energy isolating devices will also be considered to be capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

Energized: Connected to an energy source or containing residual or stored energy.

Energy Isolating Device: A mechanical device that physically prevents the transmission or release of energy, including but not limited to the following: a manually operated electrical circuit breaker; a disconnect switch; a manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors, and, in addition, no pole can be operated independently; a slide gate; a slip blind; a line valve; a block; and, any similar device used to block or isolate energy. The term does not include a push button, selector switch, and other control circuit type devices.

Energy Source: Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Lockout: The placement of a lockout device on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout Device: A device that utilizes a positive means such as a lock, either key or combination type, to hold an energy isolating device in the safe position and prevent the energizing of a machine or equipment.

Tagout: The placement of a tagout device on an energy isolating device, in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Tagout Device: A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

2.0 PURPOSE

To establish procedures for locking out and/or tagging to isolate and disable equipment to prevent accidental startup or release of stored energy, and possible injury to employees.

3.0 SCOPE

This procedure applies to all field/facility operations that require all operative energy sources, including line breaking, in the work area to be shut down, locked out and tagged, so that **CONTRACTOR** employees may safely perform their job. Contractors and subcontractors performing work on **CONTRACTOR** projects will be required to comply with these requirements if their employer does not have a comparable lock out/tag out program already in place.

4.0 PROCEDURE

1. The authorized employee will evaluate the scope of work and all equipment, machines or industrial processes in the area that require the use of stored energy. Energized equipment that may cause a safety hazard will be shut down to eliminate the potential for injury.

2. Prior to beginning the work, the authorized employee will be sure that appropriate lock out/tag out equipment is available to isolate the energy source.

3. The authorized employee will ensure that all affected employees have been trained on the following topics:

    a. Scope of Work.

    b. Energy sources.

    c. Energy isolation devices.

d. Lock out devices.

e. Tags.

f. Test procedures.

g. Authorized personnel. Those individuals charged with the responsibility for deenergizing and reenergizing energy sources).

4. A safety meeting will take place immediately prior to work, and will be documented and placed in the job folder for future reference. All employees will sign the Lockout Worksheet prior to starting the work. See Appendix A for a copy of the Lockout Worksheet.

5. All energized equipment will be shut down before **CONTRACTOR** personnel or its contractors/subcontractors begin work on site. Shut down will take place in the following manner:

a. The authorized employee will inform the client's representative of the need to shut down the equipment.

b. The authorized employee, with assistance from the client's representative, will locate all power sources on the process or equipment.

c. All power sources will be shut down and verified as such by the authorized employee.

d. A National Grid standardized lockout device must be applied by all parties entering the energized area. Each authorized employee shall affix a personal lockout or tagout device to the group lockout device. Locks and tags shall identify the identity of the employee applying the device.

e. Any necessary testing of equipment will be conducted to ensure that the process or equipment is free of energy.

f. The authorized employee will attempt to operate the machine to be sure that it remains inoperative. All activation controls will be returned to the "off" position after testing.

g. The authorized employee will apply a tag that bears the following warning, “DANGER - EQUIPMENT LOCKOUT” along with the authorized employee’s name, the date, and the time of the lockout.

h. The authorized employee will complete the Lockout Worksheet.

i. Equipment may now be released for work by the authorized employee. No release will be given until all required inspections and testing are performed.

6. Residual energy, i.e., pneumatic/hydraulic power, spring compression, and residual electrical energy in transformers are examples of residual energy that, when unsuspected, may present a greater hazard to the employee. These sources of energy will be identified, located and controlled in the following manner:

   a. Residual electrical energy can be controlled through grounding.

   b. Pneumatic/hydraulic line pressure can be released, allowing the weight to come to a rest.

   c. Spring tensions can be relieved.

   d. Product lines will be double blocked (panned) and bled to prevent product from being released.

   e. A lockout device and tag will be applied and secured by the authorized employee for the duration of the job to prevent residual energy from reaccumulating and creating a hazard to employees.

   f. The lockout/tagout will be documented by the authorized employee on the Lockout Worksheet.

7. After all work is completed, the authorized employee will perform the following:

   a. The authorized employee will inform everyone that the job is complete.

   b. The Lockout Worksheet will be reviewed by the authorized employee with all employees to make sure that all employees are accounted for before re-energizing the equipment.

   c. The authorized employee will be sure that all tools, debris or other material that could be placed into motion are removed before the equipment or process is re-energized. All employees will be instructed to stay clear of movable parts of the equipment or process.

   d. All residual energy controls will be removed by the authorized employee, as well as all energy isolation lockouts and tags.

   e. In the presence of the client's representative, energy will be restored to the equipment or process.

   f. All lockout equipment removal will be documented on the Lockout Worksheet by the authorized employee. The Lockout Sheet will be placed in the job file at the end of the shift.

8. All employees must be accounted for before re-energizing equipment. When employees that have worked on the job are absent from the final inspection before re-energizing the equipment, the authorized employee will initiate the following:

   a. The lockout sheet will be checked to account for all employees.

   b. The authorized employee will obtain a Lockout/Tagout Absent Employee form (See Appendix B).

   c. The authorized employee will appoint employees to look for the individual, paying special attention to high hazard areas where physical harm could result from the start-up of the equipment or process.

   d. After a complete search of the equipment or process, and it has been determined by the authorized employee that the employee is not present, all outlying areas surrounding the site will be searched.

   e. The area surrounding the site will be guarded to prevent the absent employee from inadvertently entering a hazardous situation.

   f. The employer must make all reasonable efforts to contact the authorized employee to inform him/her that his/her lockout or tagout device has been removed.

   g. The equipment or process will be cleared for re-energization only by the authorized employee once all of the above conditions are met.

   h. A copy of the completed Absent Employee form will be posted conspicuously in the work area, and not removed until the employee has been located. The client's representative will be notified of the situation so that the absent employee does not endanger himself/herself by entering an energized process or equipment.

9. When appropriate, contractors and subcontractors working under **CONTRACTOR**'s direction will be informed of their responsibilities, under the Lockout/Tagout Standard, to provide protection against hazardous energy.

   a. When necessary within the scope of work, contractors and subcontractors without such a program, at the discretion of **CONTRACTOR**, will be disqualified from bidding on these projects.

   b. Contractors and subcontractors with such a program will submit their program to the CHSO for review. The contractor or subcontractor program must be comparable or more strict than **CONTRACTOR**'s program.

- Programs found to be insufficient in some areas will be returned, with the requested changes to be made before the program is acceptable for implementation.

- The copy of the program will be returned to the contractor or subcontractor, and will not be duplicated by **CONTRACTOR** or any of its employees.

10. All affected employees will be given training in these procedures prior to performing any lockout/tagout work. This training will be documented and maintained in the employees' training file with the CHSO.

11. This procedure will be reviewed annually by the CHSO to ensure that it is relevant to **CONTRACTOR** operations.

APPENDIX A

LOCKOUT WORKSHEET

LOCKOUT WORKSHEET

Job Location: _____ Project Manager: _____

Date: _____ Time: _____ a.m./p.m.

Equipment Description to be locked out: _____

Equipment No:_____

Energy Source(s): _____

Pre-Work Safety Meeting Minutes: _____

Lockout Hardware Used: _____
No of locks required: _____

HAZARDOUS ENERGY		ISOLATING DEVICES			CONTROL DEVICES			
Type	Magnitude	Type	Location	I.D. No.	Lock	Tag	Both	Add'l Measures

Methods use to verify isolation:
___Design of machine reviewed
___Circuitry tested
___Are valves or hydraulic system attached to electrical sources?
___Does the electrical cabinet have any live wire circuits?
___Based on the energy sources listed above, indicate all energy isolating verification procedures required to ensure lockout

_____

_____

Energy Restoration (Check each as you Progress): Time Completed

__ All personnel accounted for and in the clear. _____

__ Point(s) of operation free of tools and debris. _____

__ Points of operation restraints removed. _____

__ Lockout hardware removed. _____

__ Personnel clear of points of operation. _____

___ Energy restored. _____

___ Equipment operation verified, client's rep on site. _____

___ Lockout terminated. _____

Employees' Signatures: _____
Date: _

APPENDIX B

LOCKOUT/TAGOUT ABSENT EMPLOYEE FORM

LOCKOUT/TAGOUT ABSENT EMPLOYEE FORM

NOTICE

Upon completion of work performed under lockout/tagout conditions, the following employee(s) listed below could not be located or accounted for:

_____

_____

_____

All attempts have been made to locate this employee at the jobsite. It has been verified that this employee is not in the vicinity of the hazardous energy source and will not be affected by the startup of equipment which was under lockout conditions.

_____ _____

Signature of Authorized Employee Date

Signature of Employer _____ Date_____

APPENDIX I

CONFINED SPACE/HOT WORK PERMITTING PROCEDURE

1.0 INTRODUCTION

Any material that is combustible or flammable is susceptible to ignition by heat-producing activity. Common materials such as floors, partitions, roofs, wooden members, paper, textiles, plastics, chemicals, flammable liquids and gases, and grass or brush are very likely to become involved in fire during hot work operations if adequate precautions are not taken.

Hot work is any work that requires the use of tools/equipment that have the potential to produce temperatures which could reasonably be expected to ignite flammable/combustible material or atmospheres in the vicinity of the work area. These tools/equipment have the capability of producing sparks, open flames, heat, or an electrical arc during use. Hot work is not limited to just welding, cutting and brazing, but also grinding, sawing (metal to metal) and chipping operations.

Confined spaces are defined as spaces that which is not designated or intended for normal human occupancy, has limited means of egress and poor natural ventilation. Confined space hazards exist if the potential for hazardous or explosive atmospheres and/or oxygen deficient hazards exist or if there is an engulfment hazard. Other hazards that could exist include mechanical sources and falls. Two types of confined spaces exist: permit required and non-permit required.

DEFINITIONS

Fire Blanket: Blanket made of fire-resistant material, such as NOMEX or KEVLAR (**not asbestos**), or treated wool, which can be used to cover combustible materials to prevent their ignition from sparks, flames or heat during hot work.

Attendant: Person who observes the confined space activities/hot work to ensure that ignition of the surrounding material does not occur. The Attendant will be equipped with a fully charged, suitable fire extinguisher and/or charged fire hose at the work area at the time of the hot work. The Attendant will not be assigned to any other duties.

Confined Space: Confined spaces are spaces that can be bodily entered but are not meant for human occupancy.

Entrant: Person who is trained and authorized to enter a confined space. Entrants are required to review air-monitoring data prior to entry into a permit required confined space PRCS and understand the hazards.

2.0 PURPOSE

To provide **CONTRACTOR** employees, who oversee hot work performed and confined space entry on projects, with a standard permitting and safety procedure to prevent injury or loss of life and property.

3.0 SCOPE

This procedure will apply to all **CONTRACTOR** employees who oversee hot work on projects utilizing welding, cutting, brazing, grinding, chipping, portable heaters, and other potential heat-producing equipment for field/facility activities. This procedure is also to be followed for all confined space entry situations. This procedure will apply to all contractors or subcontractors working under **CONTRACTOR** that do not have an adequate Permitting Procedure in place with the company in which they are currently employed. All **CONTRACTOR** employees involved with confined space entry will be properly trained for the role and duties performed. Training will consist of hands-on training with **CONTRACTOR**'s confined space entry equipment including harnesses, retrieval equipment, air-line respirators and monitoring equipment. Certification that the training was satisfactorily complete will be provided and documentation maintained.

4.0 PROCEDURE

1. Hazard Identification

    a. The Project Manager will identify all work that requires tools, equipment, or operations that may produce sparks or temperatures that are sufficient to ignite flammable/combustible materials or atmospheres.

    b. The Project Manager, SSO and CHSO will determine if a confined space entry is required and determine if the entry requires a permit. Any situation that has the potential to produce hazardous atmospheres or deplete oxygen will require a permit.

    c. This information will be included in the Site Specific Health and Safety Plan to be reviewed with the CHSO prior to starting the project.

    d. The Project Manager will determine if the work can be performed without the use of hot work, i.e. alternative method to reduce the hazard.

    e. The CHSO should consult the Project Manager if the there are questions on hazard determination. The SSO will act as the Entry Supervisor.

    f. The CHSO will review entry with the Project Manager and review this program at least annually to make sure the Program is effective and enforced. Copies of completed permits will be retained for at least one year.

    g. The permit program will be reviewed to determine if it is adequate for the projects conducted. Incident reports will be reviewed, employee issues raised and entries reviewed. The permit program will be evaluated to determine if all hazards were adequately identified and evaluated. Additional protective equipment will be purchased, if necessary, for future entries if the review process shows that all

hazards were not properly controlled. This review will be part of annual confined space training.

2. Area Preparation

a. The following preparation for the work area will be made once it is determined that hot work is necessary:

- All flammable/combustible materials will be relocated at least 35 feet away from the work area.
- All combustible materials that cannot be reasonably removed from the area will be covered with a fire blanket.

- An appropriate fully charged fire extinguisher and/or charged fire hose will be available at the work area before, during and 1/2 hour after hot work procedures have ended.

- All safety equipment will be on-site and functional.

The confined space entry area will be identified with a posted sign that reads:

Caution- Confined Space, and barricaded to prevent impact from external hazards and vehicles. Ground level entries will be ringed with a toe board to prevent objects from inadvertently being dropped into the space.

3. Pre-Work Safety Meeting

a. The Project Manager will assure that a pre-work safety meeting has been provided to the crew prior to any hot work/confined space entry being performed. Individuals involved with confined space entry will be identified as the authorized entrant(s), attendant and the entry supervisor. Additional individuals may be designated to conduct monitoring for multiple entries. This meeting will include, but not be limited to:

- Permitting conditions (environmental conditions, type of work to be performed). This would include reviewing the results of the initial monitoring of the test results, ventilation requirements, potential hazards and continuous testing procedures.

- Personnel authorized to sign-off on the permit. All personnel involved with the confined space entry must sign the permit and acknowledge the hazards expected to be encountered.

- Location of the permit. (Must be conspicuously posted.)

- Type of monitoring required.

- Designation of attendant and discussion of duties.

- Returning completed permit to Project Manager or client when work is complete and project has concluded.

b. During the pre-work safety meeting the authorized entrants will be identified and the entry procedure reviewed. The attendant will be specified and the monitoring and communication procedures reviewed. The entry will be reviewed with the designated entry supervisor before entry. The attendant will be responsible for conducting the air monitoring during the entry and providing results to the entrants and entry supervisor. The designated positions will be posted on the entry permit.

c. The entry supervisor will be responsible for meeting with the client prior to entry to identify if other contractors or client personnel will be working in close proximity to the confined space entry. The entry supervisor will coordinate entry activities in order to make sure the other work does not impact the entry or endanger entry personnel. The entry supervisor will attend scheduled project meetings with the client and other contractor representatives in order to properly coordinate the entry with other projects.

d. Initial air-monitoring results will be conducted immediately prior to entry and will be reviewed with the entry supervisor and the authorized entrants prior to entry. Air-monitoring procedures and alarm levels will also be reviewed. Ventilation of the space will be initiated before entry and periodic monitoring conducted prior to entry to verify the ventilation is adequate. Monitoring will be performed throughout entry by the attendant and entrants will wear meters with alarms to conduct monitoring during the entry.

e. The Project Manager will meet with the client to arrange for adequate rescue services from the client, if available, or from outside rescue operations. The Project Manager will discuss rescue procedures with representatives of the rescue operation and allow the rescue team to examine the area, practice the rescue and decline to act as the rescue team if they feel they are not adequately staffed or equipped. The entry cannot be conducted until adequate rescue services are provided.

f. The Project Manager will meet with the client to discuss other projects or contractors that could interfere with **CONTRACTOR**'s confined space work. **CONTRACTOR** will coordinate the entry to have minimal impact on other

contractors in the area and to make sure **CONTRACTOR** personnel are not endangered by other contractors work.

4. Permit Completion

The Confined Space Work Permit (see Appendix A) will be completed by the Project Manager prior to beginning work each day. The permit will not be considered valid until all personnel involved with the entry have reviewed and signed the entry permit. The entry supervisor will review each permit at the completion of the entry to determine if monitoring and safety procedures are adequate for this project. The permit will be modified if appropriate. The permit will be conspicuously posted at the site of the work.

5. Attendant

A designated Attendant will be present to observe the hot work/confined space operation. The Attendant will maintain contact with personnel and conduct air monitoring. The Attendant will oversee safety retrieval systems and initiate the alarm if rescue is necessary. The Attendant will not perform entry rescue or enter the confined space unless relieved of duty by another authorized Attendant and is equipped with maximum respirator protection. The Attendant will monitor only one confined space entry at one time.

6. Entrant

Entrants will be identified on the permit and instructed on the purpose for the entry of the confined space. Entrants are responsible for adhering to the permit requirements and communicating with the Attendant. Once work tasks are completed the Entrant is responsible for removing equipment, sampling devices and exiting the confined space safely.

7. Entry Procedures:

- A minimum of three workers must be assigned and dedicated to each confined space entry activity: the confined space entrant, the confined space attendant and the entry supervisor.
- Where air-moving equipment is used to ventilate space, chemicals shall be removed from the vicinity to prevent introduction into the confined space.
- If flammable liquids, gases or vapors may be contained within the confined space, explosion-proof equipment will be used. All equipment shall be positively grounded.
- Blank, double block and bleed or otherwise isolate, lockout and tagout all chemical, physical and/or electrical hazards wherever possible. Reduce all forms of energy to zero state energy.
- One person (standby) must remain at the entryway at all times and must keep continuous contact wit the person entering the confined space. Contact must be

maintained by line-of-sight, the safety line and/or radio. The standby attendant must not enter the confined space unless another trained person is available to act as standby, and he/she is equipped wit adequate respiratory protection and dermal protection.

- A ladder is required in all confined spaces deeper than the employee's shoulders. The ladder should be secured and not removed until all employees have exited the space. Do not rely on permanent ladders because they are often in poor condition. If the must be used, be sure of footing. Inspect permanent ladders for deterioration before entering and while descending. Try each step with one foot, while standing on the step above. When in doubt, use a portable ladder of adequate height to reach 3 feet above opening or a rope ladder or lower the entry person using a tripod. If a portable ladder is used, it should be tied off, if possible; otherwise, it should be held in place by the standby person.
- Vehicles should not be left running near confined space work or near air-moving equipment being used for confined space ventilation.
- Do not work without lighting. Use only "Explosion proof "lights or hand lamps. Lights and other illumination utilized in confined spaces shall be equipped with guards t prevent contact with light bulb.
- Any deviation from these confined space entry procedures requires the prior approval of the Safety Manager.

8. Atmospheric Monitoring

a. When cutting, grinding, heating or welding surfaces coated with epoxy finishes or paint, or when cutting certain metals with a welding torch, toxic fumes or vapors can be emitted in the process. In these instances, monitoring may be required under the OSHA Standard. Therefore, it is the responsibility of the Project Manager to notify the Health and Safety Coordinator of these coatings and have them sampled (if unknown) to determine what type of monitoring will be required.

b. Occasionally, a "liner" will be adhered to the inside of a metal duct or tank. When hot work will be performed on such material, the liner will be removed at least 4 inches to each side of the cut to prevent toxic vapors from being emitted, or fire from occurring.

c. After moving all flammable materials out of the work area, the area will be monitored with a Combustible Gas Meter immediately before hot work takes place. LEL readings at or above 5% will necessitate that the area be ventilated before hot work operations begin. **Hot work should not proceed if readings of five percent or below cannot be achieved.**

d. All area monitoring must be performed continuously in hot work areas.

e. Hot work performed in confined spaces requires that contaminant specific air monitoring be performed. Air monitoring should be conducted in confined spaces

whether there is hot work or not. Even non-permit spaces must be monitored initially to confirm the lack of hazardous atmospheres in the confined space. Contact the CHSO to determine the type of air monitoring required for the contaminant.

f. Hot work performed on containers that previously contained flammable liquids (i.e. underground storage tanks) will not be performed until the Health and Safety Division has been contacted and has approved the work to be performed. **CONTRACTOR**'s Site Specific Health and Safety Plan for Flammable and Combustible Underground Storage Tank Removals contains detailed procedures for cleaning, inerting and cutting these types of containers.

g. Entrants and the attendant will continuously evaluate the permit-required space to determine if additional monitoring or more frequent monitoring is necessary. The permit may be revoked or modified accordingly. All entrants will leave the space if unsafe conditions are observed or measured. The permit will be invalidated and reviewed with the supervisor before re-entry is allowed. Additional monitoring will be performed at the request of employees or attendants. Atmospheric monitoring for confined space entry shall include the following procedures:

- Prior to employee entry and before validation/revalidation of a CSEP, remote atmospheric testing of the confined space shall be conducted at the top, middle, bottom and corners of the space.
- Monitoring shall be conducted with a remote monitor on a wand attached to a toxic gas meter. The monitor shall be able to reach the lowest point of the confined space.
- Air monitoring shall be performed in the following sequence: Oxygen content, flammability, toxicity (organic vapors, hydrogen sulfide, carbon monoxide, etc.)
- If toxic , explosive or oxygen-deficient atmospheres are detected, the area will be purged or ventilated prior to entry. Area must be retested prior to entry. A person can enter the space only if all three test results are within the limits set in the permit.
- If remote testing is not possible, Level B is required for entry.
- Monitors for oxygen content, combustible gases and toxic vapors will be carried into the confined space with the entry team.

9. Prohibitive Circumstances

a. Hot work will be prohibited if any of the following conditions exist:

- Oxygen levels greater than 21%.

- LEL greater than 5%.

- Organic vapor concentration greater than half of the Permissible Exposure Limits depending on contaminant (ventilation may reduce this hazard).

- Confined space entry will not be permitted if oxygen levels are below 19.5% or if the LEL is >10%. Individual hazardous constituents will be monitored and appropriate levels of respiratory protection will be issued.

10. Conditions of Permit Validity

a. A permit is not valid unless all necessary inspections and air monitoring (if required) have been performed and all required signatures appear on the permit.

b. Work permits will be judged as valid for the following time durations:

- Work Shift or when until a significant change in personnel occur.

- Duration of the hot work.

- When atmospheric changes dictate ceasing the operation, abate the hazard and reinspect the work area before completing another permit.

c. Permits are valid up to one day and new permits must be completed each day or whenever the permit conditions change.

d. The local Fire Department or client emergency services will be contacted prior to entry into confined spaces. They will be notified of the reason for entry and be requested to be available for rescue and administrating first aid. If emergency rescue cannot be provided within three minutes **CONTRACTOR** will not conduct the entry. The permit program will be reviewed to determine if it is adequate for the projects conducted. Incident reports will be reviewed, employee issues raised and entries reviewed. The permit program will be evaluated to determine if all hazards were adequately identified and evaluated. Additional protective equipment will be purchased, if necessary, for future entries if the review process shows that all hazards were not properly controlled. This review will be part of annual confined space training.

e. **CONTRACTOR** will coordinate the entry with client and/or other contractors present at the job site. Work will be evaluated to determine the impact by non-**CONTRACTOR** staff on the work being conducted.

f. If conditions change and **CONTRACTOR** employees are at risk the permit will be considered invalid.

g. The permit will be canceled once the project is complete or conditions change that warrant leaving the site. A new permit will be issued for future entries once a permit has been canceled.

11. Training and Program Review

All workers involved with confined space entry will receive training relative to their role on the project. Since **CONTRACTOR** conducts confined space entry infrequently training will be conducted prior to each project in order to refresh **CONTRACTOR** employees on the use of the equipment, monitoring procedures and the confined space entry program. The program will be reviewed annually or when new equipment is acquired. All completed permits will be reviewed and critiqued at the completion of each entry. The entrants and attendants will be interviewed after entry to determine if there were significant problems or concerns.

APPENDIX A

CONFINED SPACE PERMIT

CONTRACTOR

Confined Space Entry Permit

- Location of Confined Space _____ Date/time _____
  Purpose of entry _____ Duration _____
  Authorized by _____ ***Expires on*** _____

Attendant _____
Authorized Entrants _____

Measures for Isolating Equipment	**YES**	**NO**	Measures for Isolating Equipment	**YES**	**NO**
LOTO			Protective clothing		
Lines capped			Communications equipment		
Purging			Hot work permit needed		
Ventilation			Other PPE		
Secure area			**Special conditions**		
Harness and retrieval system			Pump out standing water		
Fire extinguishers			Excessive Heat		
Air line system/5-minute escape bottle			Low overhead		
SCBAs			Slippery surfaces		
Other Respirators			Unsecured ladder		

Atmospheric Monitoring

Tests to be Taken	yes	no	Acceptable Entry Conditions	Test # Date: Time:	1	2	3	4	5	6	7	8	9	10
Oxygen			19.5-23.5%											
LEL			<10%											
CO			<25 ppm											
H_2S			<5 ppm											
Other														

Individual conducting test: _____
Supervisor authorizing entry _____

Instruments used:

Instrument(s) name	Type	Serial #

Authorized Entrants within Space

Entrant's Name	Time In	Time Out	Authorized site Attendants

Emergency and rescue contact: _____

Entry supervisor approval to conduct entry _____ Date/time _____

APPENDIX J

INCIDENT REPORTING

1.0 ACCIDENT AND INCIDENT REPORTING

It is important that all accidents and incidents that result in injury, illness, or medical treatment be reported within 24 hours. If an accident occurs, the Contractor will call their Human Resources Director and Corporate Environmental Safety Manager (CHSO) to provide information on the injury. The CHSO will complete the first report of injury and file it accordingly. Copies will be sent to the Project Manager (PM) and Site Safety Officer (SSO). Supervisors are required to complete the Supervisor's Report of Accident included in this section. It is **CONTRACTOR'S** responsibility to investigate each incident, file appropriate paperwork, and conduct a follow-up analysis of each incident to develop information about the cause of the accident.

2.0 REPORTING PHONE NUMBERS

Corporate Environmental Safety Manager: **Robin DeHate – 813.323.6220**
Human Resources Director: **Linda Penkes – 860.368.5376**

3.0 FIRST AID AND MEDICAL TREATMENT

The **CONTRACTOR** provides a First Aid Kit on each site and in each Company vehicle. It is there for use in the treatment of minor scratches, burns, headaches, nausea, etc. Each employee should verify the location of the nearest first aid kit and should make use of it whenever needed. Each kit is fully stocked and restocked monthly by an outside vendor. The kit includes bandages, over the counter medications, disinfecting supplies and topical ointments. The user of each kit is responsible for contacting the vendor to replace items used or submitting the kit to **CONTRACTOR** for replacement. Kits are to be inventoried by the Project Manager before being sent in the field. Only completely stocked kits are to be brought into the field. The kits are maintained in a weatherproof container and in accordance with ANSI Standard Z308.1-1998. The first aid supplies in each kit are included in Appendix A.

Any work related injury or illnesses that requires professional medical assistance should be reported immediately. Failure to promptly notify of a work related injury could make the claim questionable and subject to stricter review. The nearest medical center or hospital will be identified for each project. The phone number and location for this center will be determined before commencing field activities and be included in the Health and Safety Plan. The phone numbers will be posted by Site Safety Officer (SSO) or the Project Manager (PM) and available to all employees in order to provide prompt response to all injuries. The SSO or the PM will contact the nearest medical facility to determine the facility's capabilities and verify that the facility is willing to provide emergency medical services. The following actions for medical treatment scenarios is presented below:

1. Minor First Aid Treatment

   First aid kits are stored in each company vehicle. If an injury is sustained or results in minor first aid treatment:

   a. Inform your supervisor.

b. Administer first aid treatment to the injury or wound.
c. If a first aid kit is used, indicate usage on the accident investigation report.
d. Access to a first aid kit is not intended to be a substitute for medical attention.
e. Provide details for the completion of the accident investigation report.

2. Non-Emergency Medical Treatment

For non-emergency work-related injuries requiring professional medical assistance, management must first authorize treatment. If you sustain an injury requiring treatment other than first aid:

a. Inform your supervisor.

b. Proceed to the posted medical facility. Your supervisor will assist with transportation, if necessary.

c. Provide details for the completion of the accident investigation report.

3. Emergency Medical Treatment

If you sustain a severe injury requiring emergency treatment:

a. Call for help and seek assistance from a co-worker.

b. Use the emergency telephone numbers and instructions posted next to the telephone in your work area to request assistance and transportation to the local hospital emergency room.

c. Provide details for the completion of the accident investigation report.

d. The Project Manager will identify an ER provider for each long-term project for emergency medical services. The phone number will be posted at each job site.

4. First Aid Training

Each employee will receive training and instructions from his or her supervisor on our first aid procedures.

5. Wounds

a. Minor - Cuts, lacerations, abrasions, or punctures

- Wash the wound using soap and water; rinse it well.
- Cover the wound using clean dressing.

b. Major - Large, deep and bleeding

- Stop the bleeding by pressing directly on the wound, using a bandage or cloth.
- Keep pressure on the wound until medical help arrives.

6. Broken Bones

   a. Do not move the victim unless it is absolutely necessary.

   b. If the victim must be moved, “splint” the injured area. Use a board, cardboard, or rolled newspaper as a splint.

7. Burns

   a. Thermal (Heat)

      - Rinse the burned area, without scrubbing it, and immerse it in cold water; do not use ice water.

      - Blot dry the area and cover it using sterile gauze or a clean cloth.

   c. Chemical

      - Flush the exposed area with cool water immediately for 15 to 20 minutes.

8. Eye Injury

   a. Small particles

      - Do not rub your eyes.

      - Use the corner of a soft clean cloth to draw particles out, or hold the eyelids open and flush the eyes continuously with water.

   b. Large or stuck particles

      - If a particle is stuck in the eye, do not attempt to remove it.
      - Cover both eyes with bandage.

   c. Chemical

      - Immediately irrigate the eyes and under the eyelids, with water, for 30 minutes.

9. Neck and Spine Injury

   If the victim appears to have injured his or her neck or spine, or is unable to move his or her arm or leg, do not attempt to move the victim unless it is absolutely necessary.

10. Heat Exhaustion

    a. Loosen the victim's tight clothing.
    b. Give the victim "sips" of cool water.

Make the victim lie down in a cooler place with the feet raised.

4.0 FIRST AID/CPR Certification

Each **CONTRACTOR** project will have at least one certified CPR/first aid trained person on site at all times. The Site Safety Officer must identify individuals that are current in First Aid/CPR. First aid training sponsored by the American Red Cross is acceptable and must be renewed every three years. CPR training must be renewed annually. Other first aid training will be reviewed to see if it is comparable to the Red Cross training.

5.0 SAFETY RESPONSIBILITIES

The Contractor and Subcontractor employees also have some important responsibilities concerning safety. They are:

a. The responsibility of reporting all injuries and illnesses to your supervisor, no matter how small.

b. The responsibility of always following the safety rules for every task performed.

c. The responsibility of reporting any hazards seen.

d. The responsibility of helping co-workers recognize unsafe actions or conditions.

e. The responsibility of asking about the safety rules.

It is impossible to list or include all safety rules for all the possible tasks. But the following rules have been prepared to help the employee avoid hazards, which may cause injury while doing some of the more common tasks. Failure to follow safety rules and /or safe practices will result in disciplinary action, up to and including termination.

Supervisor's Report of Accident

Supervisor's Name: _____

Basic Rules for Accident Investigation

- Find the cause to prevent future accidents - Use an unbiased approach during investigation
- Interview witnesses & injured employees at the scene - conduct a walkthrough of the accident
- Conduct interviews in private - Interview one witness at a time.
- Get signed statements from all involved.
- Take photos or make a sketch of the accident scene.
- What hazards are present - what unsafe acts contributed to accident
- Ensure hazardous conditions are corrected immediately.

Date & Time		**Location**	
Tasks performed		**Witnesses**	
Resulted in	**__ Injury __ Fatality** **__Property Damage**	**Property Damage**	
Injured		**Injured**	
Describe Accident Facts & Events			

Supervisor's Root Cause Analysis		*Check ALL that apply to this accident*	
Unsafe Acts		**Unsafe Conditions**	
Improper work technique		Poor Workstation design	
Safety rule violation		Unsafe Operation Method	
Improper PPE or PPE not used		Improper Maintenance	
Operating without authority		Lack of direct supervision	
Failure to warn or secure		Insufficient Training	
Operating at improper speeds		Lack of experience	
By-passing safety devices		Insufficient knowledge of job	
Protective equipment not in use		Slippery conditions	
Improper loading or placement		Excessive noise	
Improper lifting		Inadequate guarding of hazards	
Servicing machinery in motion		Defective tools/equipment	
Horseplay		Poor housekeeping	
Drug or alcohol use		Insufficient lighting	
Unsafe Acts require a written warning and re-training <u>before</u> the Employee resumes work			
Date		**Date**	

Re-Training Assigned		Unsafe Condition Guarded	
Re-Training Completed		Unsafe Condition Corrected	
Supervisor Signature		**Supervisor Signature**	

Accident Report Review

Supervisor _____ Date _____

Department Superintendent _____ Date _____

Safety Manager _____ Date _____

Plant Manager _____ Date _____

APPENDIX A

First Aid Kits

Each first aid kit is in a weather proof container and contains the following:

Item	Amount
Ear Plugs	2 pair
Band-aids	2 boxes
Sterile pads	5 2”x2”
Oval eye pads	2
Tylenol	10
Burn cream	1 tube
Tweezers	1 each
Scissors	1 each
Triangular bandage	1
Antiseptic wipes	1 box
Ammonia inhalants	1 box
Flexible gauze	1 roll
First aid guide	
Latex gloves	2 pair

APPENDIX K

ADDENDUM

Community Air Monitoring Plan
Greenpoint Energy Center
Remedial Investigation
Brooklyn, New York

In accordance with NYSDEC and NYSDOH requirements for a Community Air Monitoring Plan (CAMP), a perimeter air-monitoring plan, will be implemented at the site during each phase of the field activities. The objective of the perimeter air-monitoring plan is to provide a measure of protection for the downwind community (i.e., off-site receptors, including residences and businesses and on-site workers not involved with the site field activities) from potential airborne contaminant releases as a direct result of field activities. The perimeter air-monitoring plan is a stand-alone document and will be available on site. The VOC Monitoring, Response Levels, and Actions are presented as follows.

Air Monitoring Response Levels and Actions

VOCs	
Response Level	**Actions**
>5 ppm above background for 15-minute average	▪ Temporarily halt work activities ▪ Continue monitoring ▪ If VOC levels decrease (per instantaneous readings) below 5 ppm over background, work activities can resume
Persistent levels >5 ppm over background <25 ppm	▪ Halt work activities ▪ Identify source of vapors ▪ Corrective action to abate emissions ▪ Continue monitoring ▪ Resume work activities if VOC levels 200 feet downwind of the property boundary or half the distance to the nearest potential receptor is <5 ppm for a 15-minute average ▪ If VOC levels are >25 ppm at the perimeter of the work area, activities must be shutdown
Particulate	
>100 mcg/m3 above background for 15-minute average or visual dust observed leaving the site	▪ Apply dust suppression ▪ Continue monitoring ▪ Continue work if downwind PM-10 particulate levels are <150 mcg/m3 above upwind levels and no visual dust leaving site
>150 mcg/m3 above background for 15-minute average	▪ Stop work ▪ Re-evaluate activities ▪ Continue monitoring ▪ Continue work if downwind PM-10 particulate levels are <150 mcg/m3 above upwind levels and no visual dust leaving site

Sources:

New York State Department of Health Community Air Monitoring Plan, June 20, 2000.
New York State Department of Environmental Conservation Division Technical and Administrative Guidance Memorandum - Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites, October 27, 1989.

During excavating and materials handling operations, the air in work areas will also be sampled periodically for the presence of contaminants. A portable photoionization detector (PID) will be utilized to periodically monitor the levels of organic vapors in the ambient air and a Mini RAM™ PM-10 (or equivalent) particle detector will be used to count inhalable particles (0.1-10 micrometer range) of dust during the field work. PID and Mini RAM readings will be taken hourly during excavation or more frequently if air quality measurements approach action levels as defined herein. Measurements will be monitored from the breathing zone (4 to 5 feet above ground level) at worker locations to determine working conditions (and whether there is a need to change levels of worker protection).

In addition to VOCs and particulates, cyanide will be monitored in the work zone and at the perimeter of the work area. The cyanide monitoring methods will be determined prior to mobilization, but at a minimum, will include Drager® tube sampling.

In order to make a conservative assessment of when different levels of respiratory protection are needed during the field work, it will be assumed that the organic vapors detected by the air monitoring instruments consist of the most toxic volatile compounds expected to be found on the site. Preliminary evaluation of the risks expected at the site indicates that the most toxic volatiles that are probably present are VOCs (particularly BTEX). Based on data published by the Occupational Safety and Health Administration (OSHA) and the American Conference of Government Industrial Hygienists (ACGIH), and experience with MGP wastes, the following PPE will be employed when the given concentrations of organic vapor are detected in the breathing zone.

Compound of Concern	**Level D**	**Level C**	**Level B**
Chemical Name	M<X	X<M<Y	M>Y
BTEX and other photoionizable VOCs	M <5 ppm	5 ppm <M <50 ppm	M >50 ppm
Where: M = concentration of organic vapor measured in the field X,Y= concentrations at which different levels of respiratory protection are necessary.			

The PPE requirements may be modified based on compound-specific monitoring results information, with the written approval of the Corporate Health and Safety Officer (CHSO).

Respiratory protection from dusts will be required when inhalable particulate concentrations from potentially contaminated sources exceed 150 µg/$m^{3.}$

Odors or dusts derived from site contaminants may cause nausea in some site workers, even though the contaminants are at levels well below the safety limits as defined above. Workers may use dust masks or respirators to mitigate nuisance odors with the approval of the SSO.

Whenever practical, work areas should be positioned upwind of organic vapor and dust sources to reduce the potential for worker exposure.

MATERIAL SAFETY DATA SHEETS

Genium Publishing Corporation
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Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

Issued: 11/78 Revision: E, 8/90

Section 1. Material Identification

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.
Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA



HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8

Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
%Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	Autoignition Temperature: 928 °F (498 °C)	LEL: 1.3% v/v	UEL: 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.
Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

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Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection **References:** 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 409
Cresol (Mixed Isomers)

Issued: 12/78 Revision: B, 3/92

Section 1. Material Identification

Cresol, *mixed isomers* ($CH_3C_6H_4OH$) **Description:** Derived from coal tar or petroleum. Cresol is marketed by individual isomer and as pure or crude cresol. Pure cresol is a mixture of *ortho*, *meta*, and *para* isomers. Crude cresol (commercial cresol) is prepared by distilling "grey phenic acid" at 356 to 401 °F (180 to 205 °C) and is comprised of 20% *ortho*, 40% *meta*, and 30% *para* isomers, plus small amounts of phenol and xylenols. Each isomer can be prepared synthetically by diazotization of the specific corresponding toluidine. Used in manufacturing synthetic resins, explosives, photographic developers, petroleum, paint, disinfectants, and fumigants; as an ore flotation agent; and in the agriculture industry for herbicides and insecticides.
Other Designations: CAS No. 1319-77-3, Bacillol, cresylic acid, Tekresol, tricresol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Cresol is severely irritating to mucous membranes, eyes, and skin. Depending on the cresol concentration, extent of exposure, and amount of skin exposed, toxicity may be slight (irritation) or severe (permanent injury or death).

R 1
I 4
S 3*
K 2
* Skin absorption

NFPA



HMIS
H 3
F 2
R 0
PPG†
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Cresol (*mixed isomers*) National Formulary (NF) grade contains < 5% phenol

1990 OSHA PEL (Skin)
8-hr TWA: 5 ppm (22 mg/m³)

1990 NIOSH REL
TWA: 5 ppm (22 mg/m³)

1990 IDLH Level
250 ppm

1991-92 ACGIH TLV (Skin)
TWA: 5 ppm (22 mg/m³)

1990 DFG (Germany) MAK
TWA: 5 ppm (22 mg/m³) (H)*
Peak Exposure Limit: 10 ppm, 5 min, momentary value/8 per shift

1985-86 Toxicity Data†
Rat, oral, LD_{50}: 1454 mg/kg; toxic effects not yet reviewed
Mouse, inhalation, LC_{50}: 179 mg/m³/2 hr; no toxic effects noted (*o*-)
Rabbit, eye: 103 mg produced severe irritation (*p*-)
Rabbit, skin: 517 mg applied for 24 hr produced severe irritation (*m*-)
Rabbit, skin, LD_{50}: 2000 mg/kg; toxic effects not yet reviewed

* Danger of cutaneous absorption.
† See NIOSH, *RTECS* (GO5950000), for additional toxicity data. For data on specific isomers, see *RTECS* (GO6125000, *meta*; GO6300000, *ortho*; and GO6475000, *para*).

Section 3. Physical Data

Boiling Point Range: 375.8 to 397.4 °F (191 to 203 °C)
Melting Point Range: 51.8 to 95 °F (11 to 35 °C)
Vapor Pressure: 0.25 (*ortho*), 0.15 (*meta*), 0.11 (*para*) mm Hg at 68 °F (20 °C)
Vapor Density (air = 1): 3.72
pH: Saturated solutions are neutral or slightly acidic to litmus
Viscosity: 4.49 to 7.0 cP at 104 °F (40 °C)
Molecular Weight: 108.13
Specific Gravity: 1.030 to 1.038 at 77 °F (25 °C)
Water Solubility: Soluble, 1%
Other Solubilities: Soluble in alcohol, ether, dilute alkalies, glycol and vegetable oils
Refraction Index: 1. 5353 at 75.2 °F (24 °C)
Odor Threshold: Low, 0.012 mg/m³; high, 22 mg/m³

Appearance and Odor: Colorless, yellow, or pinkish liquid turning brown on exposure to air or light with a phenolic odor and pungent taste.

Section 4. Fire and Explosion Data

Flash Point: 178 °F (81.11 °C, *ortho*), 187 °F (86.11 °C, *meta* and *para*), CC	**Autoignition Temperature:** 1110 °F (559 °C, *ortho*), 1038 °F (558 °C, *meta* and *para*)	**LEL:** 1.4% (*ortho*), 1.1% (*meta* and *para*) at 302 °F (150 °C)	**UEL:** None reported

Extinguishing Media: While cresol does not ignite easily, it burns. For small fires, use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam. Do not scatter material with more water than is necessary to put out fire.
Unusual Fire or Explosion Hazards: Container may explode in heat of fire.
Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is ineffective for fires involving cresol. Use clothing the manufacturer recommends specifically for use with cresol. If possible without risk, remove container from fire area. Fight fire from maximum distance. Stay away from ends of tanks. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Cresol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Cresol reacts with oxidizing materials and causes a temperature and pressure increase with chlorosulfonic acid, nitric acid, and oleum.
Conditions to Avoid: Ignition sources and contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of cresol can produce carbon dioxide (CO_2) and toxic cresol fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(142) and OSHA(164) do not list cresol as a carcinogen. **Summary of Risks:** Cresol is corrosive to eyes, skin, and mucous membranes. Degree of toxicity depends on the cresol concentration involved, amount of surface area exposed, and duration of exposure. Ingestion is corrosive to the digestive tract's mucous membranes and can pose serious problems if not treated promptly. Because cresol has a low vapor pressure, it is not volatile enough under normal conditions to present an inhalation hazard. If heated, vapor inhalation is likely. Severe chemical burns and dermatitis are the main hazards in industry. Note that cresol's *ortho* and *para* isomers (if used individually) are in crystal form and thus are a dust inhalation hazard. By all routes of exposure, cresol produces toxic symptoms similar to phenol's. **Medical Conditions Aggravated by Long-Term Exposure:** Skin diseases. **Primary Entry Routes:** Skin and eye contact/absorption. **Acute Effects: Target Organs:** Eyes, skin, central nervous system (CNS), liver and kidney. Cresol is absorbed through skin, open wounds, and the mucous membranes of the respiratory and digestive tracts. The rate at which skin absorbs cresol depends more on the size of exposure area than on the concentration of material applied. Cresol is corrosive to the skin causing smarting; tingling; redness; swelling; burns that may be very painful and become white and wrinkled with softening that may become gangrenous; blisters; possible shock as a result

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Section 6. Health Hazard Data, *continued*

of pain; and, in severe cases of absorption, coma and death. Contact with eyes may cause stinging, and burning, watering of eyes, redness and swelling of lids, corneal opaqueness causing blurred vision and possible loss of sight. In rare cases, a pigment disorder called ochronosis occurs characterized by darkening of skin, conjunctiva, and cartilage of the nose and ears. Ingestion leads to burning of lips, mouth, and throat, pain in swallowing, ulceration of the mucous membranes of the mouth, color change of the tongue (white), thirst, throat swelling, cramps, nausea and vomiting (sometimes of coffee grounds-like material due to digestive hemorrhage). In severe cases symptoms might progress to shock, convulsions, coma, and death. If vapor inhalation occurs, symptoms include irritation of mucous membranes of nose, eyes, and mouth, watering of eyes, sneezing, coughing, difficulty breathing, headache, nausea, muscle weakness, and possible pulmonary edema. In most cases of exposure, if death occurs, it is usually caused by respiratory failure. **Chronic Effects:** Repeated exposure to cresol may cause digestive disturbances, liver, kidney, spleen and pancreatic damage, and skin eruptions or dermatitis. Some people can become allergic or hypersensitive to cresol.

FIRST AID: *Emergency personnel should protect against contamination.*

Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* allow victim to rub or keep eyes tightly shut. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing to prevent burns. Rinse with flooding amounts of water for at least 15 min. If clothing is stuck to skin after flushing with water, *do not* remove! Thoroughly wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting with 2 tablespoons of Ipecac (adult dose). After patient vomits, give activated charcoal in 8 oz. of water to drink. **After first aid, get appropriate in-plant, paramedic, or community medical support.**

Note to Physicians: Since effects may be delayed, keep victim under observation. Irrigate eyes and wash skin with a mixture of polyethylene glycol 300 and industrial methylated spirits (PEG 300/IMS, 2:1 by volume). Recommended treatment for ingestion is repeated gastric lavage with large quantities of olive oil.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area (with fixed or portable fan systems for cross-ventilation), deny entry, and stay upwind. Shut off all ignition sources. Spilled liquid can be neutralized with crushed limestone or soda ash. Take up small spills with earth, sand, vermiculite or other absorbent, noncombustible material and place into suitable containers. For large spills, dike far ahead of liquid for later disposal or reclamation. For water spills, you may need to trap cresol at the bottom with sandbag barriers, apply activated charcoal, and then remove trapped material with dredges or lifts. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Degradation: When released into the atmosphere, cresol degrades by reacting with photochemically produced hydroxyl radicals during the day (half-life = 8 to 10 hr), and with nitrate radicals at night (half-life = 2 to 5 min). Cresol biodegrades in eutrophic (nutrient-rich) waters.

Ecotoxicity Values: Blue gill, TL_m, 24 mg/L/96 hr (fresh water); shrimp, TL_m, 10 to 100 ppm/48 hr (saltwater).

Soil Absorption/Mobility: Cresol is mobile in soil but biodegradation is probable. Cresols probably leach due to water solubility.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U052*

Listed as a CERCLA Hazardous Substance† (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [† per RCRA, Sec. 3001 and CWA, Sec. 311(b)(4)]

Listed (*o-cresol only*) as a SARA Extremely Hazardous Substance (40 CFR 355)

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

* When a spent solvent and classified as a hazardous waste from nonspecific sources, cresol has Hazardous Waste No. F004.

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles or faceshields to protect against droplets or spray, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. At 50 to 500 ppm use a full face gas mask. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Rubber is suggested as a material suitable for protection against cresol.

Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in properly labelled (with trade name) iron or steel containers in cool, dry, well-ventilated location. Protect from light and keep away from incompatibles (Sec. 5). Outside or detached storage is preferred. To prevent static sparks, electrically ground and bond all equipment used in cresol manufacture, use, and storage.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Administrative Controls: Consider preplacement and periodic examinations of exposed workers that emphasize skin, kidney, liver, and respiratory system.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Cresol
DOT Hazard Class: Corrosive material
ID No.: UN2076
DOT Label: Corrosive
DOT Packaging Exceptions: 173.244
DOT Packaging Requirements: 173.245

IMO Shipping Name: Cresols (*o-, m-, p-*)
IMO Hazard Class: 6.1
ID No.: UN2076
IMO Label: Poison
IMDG Packaging Group: II

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 153, 159, 162, 163, 164

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 385
Ethylbenzene

Issued: 8/78 Revision: B, 9/92

Section 1. Material Identification

Ethylbenzene ($C_6H_5C_2H_5$) Description: Derived by heating benzene and ethylene in presence of aluminum chloride with subsequent distillation, by fractionation directly from the mixed xylene stream in petroleum refining, or dehydrogenation of naphthenes. Used as a solvent, an antiknock agent in gasoline; and as an intermediate in production of synthetic rubber, styrene, cellulose acetate, diethylbenzene, acetophenone, ethyl anthraquinone, propyl oxide, and α-methylbenzol alcohol.
Other Designations: CAS No. 100-41-4, ethylbenzol, EB, phenylethane, NCI-C56393.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 3
S 2*
K 4
* Skin absorption

NFPA



HMIS
H 2†
F 3
R 0
PPE - Sec. 8
† Chronic effects

Cautions: Ethylbenzene is a skin and mucous membrane irritant considered the most irritating of the benzene series. Inhalation causes acute and chronic central nervous system (CNS) effects. It is highly flammable and forms explosive mixtures with air.

Section 2. Ingredients and Occupational Exposure Limits

Ethylbenzene, ca >99.0%. Impurities include ~ 0.1% *meta* & *para* xylene, ~ 0.1% cumene, and ~ 0.1% toluene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m³)
15-min STEL: 125 ppm (545 mg/m³)
Action Level: 50 ppm (217 mg/m³)

1990 IDLH Level
2000 ppm

1990 NIOSH REL
TWA: 100 ppm (435 mg/m³)
STEL: 125 ppm (545 mg/m³)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m³)
STEL: 125 ppm (545 mg/m³)

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m³)
Category 1: local irritants
Peak Exposure Limit: 200 ppm, 5 min momentary value, max of 8/shift
Danger of cutaneous absorption

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 100 ppm/8 hr caused eye effects, sleep, and respiratory changes.
Human, lymphocyte: 1 mmol/L induced sister chromatid exchange.
Rat, oral, LD_{50}: 3500 mg/kg; toxic effects not yet reviewed
Rat (female), inhalation, TC_{Lo}: 1000 ppm/7 hr/day, 5 days/wk, for 3 wk prior to mating and daily for 19 days of gestation produced pups with high incidence of extra ribs.[179]

* See NIOSH, *RTECS* (DA0700000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 277 °F (136 °C)
Melting Point: -139 °F (-95 °C)
Surface Tension: 31.5 dyne/cm
Ionization Potential: 8.76 eV
Viscosity: 0.64 cP at 77 °F (25 °C)
Refraction Index: 1.4959 at 68 °F (20 °C)
Relative Evaporation Rate (ether = 1): 0.0106
Bulk Density: 7.21 lb/Gal at 77 °F (25 °C)
Critical Temperature: 651 °F (343.9 °C)
Critical Pressure: 35.6 atm

Molecular Weight: 106.16
Density: 0.863 at 77 °F (25 °C)
Water Solubility: Slightly, 14 mg/100 mL at 59 °F (15 °C)
Other Solubilities: Miscible in alcohol, ether; soluble in carbon tetrachloride, benzene, sulfur dioxide, and many organic solvents; insoluble in ammonia
Odor Threshold: 2.3 ppm
Vapor Pressure: 7.1 mm Hg at 68 °F (20 °C); 10 mmHg at 78.62 °F (25.9 °C); 100 mm Hg 165.38 °F (74.1 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.0768 lb/ft³ or 1.2298 kg/m³

Appearance and Odor: Colorless, flammable liquid with a pungent odor.

Section 4. Fire and Explosion Data

Flash Point: 64 °F (18 °C) CC	**Autoignition Temperature:** 810 °F (432 °C)	**LEL:** 1.0% v/v	**UEL:** 6.7% v/v

Extinguishing Media: Class 1B Flammable liquid. For small fires, use dry chemical, carbon dioxide, or 'alcohol-resistant' foam. For large fires, use fog or 'alcohol-resistant' foam. Use water only if other agents are unavailable; EB floats on water and may travel to an ignition source and spread fire. **Unusual Fire or Explosion Hazards:** Burning rate = 5.8 mm/min. Vapors may travel to an ignition source and flash back. Container may explode in heat of fire. EB poses a vapor explosion hazard indoors, outdoors, and in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Cool container sides with water until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw immediately if you hear rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Ethylbenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Reacts vigorously with oxidizers.
Conditions to Avoid: Exposure to heat and oxidizers.
Hazardous Products of Decomposition: Thermal oxidative decomposition of EB can produce acrid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list EB as a carcinogen. **Summary of Risks:** Occupational exposure to EB alone is rare since it is usually present together with other solvents. EB is irritating to the eyes, skin, and respiratory tract. Vapor inhalation produces varying degrees of CNS effects depending on concentration. The liquid is absorbed through the skin but vapors are not. 56 to 64% of inhaled ethylbenzene is retained and metabolized. Urinary metabolites following exposure to 23 to 85 ppm for 8 hr are mandelic acid (64%), phenylglyoxylic acid (25%), and methylphenylcarbinol/1-phenyl ethanol (5%). Concurrent exposure to xylene and ethylbenzene causes slower excretion of EB metabolites. Based on the rat LD_{50}, one manufacturer gives 3 to 4 oz. as the lethal dose for a 100 lb person.

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Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Skin and CNS diseases and impaired pulmonary function (especially obstructive airway disease). **Target Organs:** Eyes, respiratory system, skin, CNS, blood. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute Effects:** Vapor inhalation of 200 ppm caused transient eye irritation; 1000 ppm caused eye irritation with profuse watering (tolerance developed rapidly); 2000 ppm caused severe and immediate eye irritation and watering, nasal irritation, chest constriction, and vertigo; 5000 ppm was intolerable and caused eye and nose irritation. Inhalation of high concentrations may cause narcosis, cramps, and death due to respiratory paralysis. Skin exposed to pure ethylbenzene for 10 to 15 min absorbed 22 to 33 mg/cm^2/hr. Immersion of hand in solutions of 112 & 156 mg/L for 1 hr absorbed 118 & 215.7 µg/cm^2/hr, respectively. **Chronic Effects:** Repeated skin contact may cause dryness, scaling, and fissuring. Workers chronically exposed to > 100 ppm complained of fatigue, sleepiness, headache, and mild irritation of the eyes and respiratory tract. Repeated vapor inhalation may result in blood disorders, particularly leukopenia (abnormally low level of white blood cells) and lymphocytosis.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting! Aspiration of even a small amount of EB in vomitus can cause severe damage since its low viscosity and surface tension will cause it to spread over a large area of the lung tissue.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI = mandelic acid in urine (1.5 g/g of creatinine), sample at end of shift at workweeks end. Since this test is not specific, test for EB in expired air for confirmation.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate and ventilate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container. Dike far ahead of large spill for later reclamation or disposal. Report any release >1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, EB partially evaporates into the atmosphere, with a half-life of hrs to wks, and some leaches into groundwater, especially in soil with low organic carbon content. Biodegradation occurs with a half-life of 2 days. Some EB may absorb to sediment or bioconcentrate in fish. Evidence points to slow biodegradation in groundwater. In air, it reacts with photochemically produced hydroxyl radicals with a half-life of hrs to 2 days. Additional amounts may be removed by rain. **Ecotoxicity Values:** Shrimp (*Mysidopsis bahia*), LC_{50} = 87.6 mg/L/96 hr; sheepshead minnow (*Cyprinodon variegatus*) LC_{50} = 275 mg/L/96 hr; fathead minnow (*Pimephales promelas*) LC_{50} = 42.3 mg/L/96 hr in hard water & 48.5 mg/L/96 hr in softwater. **Disposal:** A candidate for rotary kiln incineration at 1508 to 2912°F (820 to 1600°C), liquid injection incineration at 1202 to 2912°F (650 to 1600°C), and fluidized bed incineration at 842 to 1796°F (450 to 980°C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.21): No. D001
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311 (b)(4) & CWA, Sec. 307 (a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use a powered air-purifying respirator with an appropriate organic vapor cartridge, a supplied-air respirator (SAR), SCBA, or chemical cartridge respirator with appropriate organic vapor cartridge. For < 2000 ppm, use a SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton or polyvinylchloride to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a cool, dry, well-ventilated area away from ignition sources and oxidizers. Outside or detatched storage is preferred. If inside, store in a standard flammable liquids cabinet. Containers should have flame-arrester or pressure-vacuum venting. To prevent static sparks, electrically ground and bond all equipment used with ethylbenzene. Install Class 1, Group D electrical equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain levels as low as possible. Purge and ventilate reaction vessels before workers are allowed to enter for maintenance or cleanup. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, skin, blood, and respiratory system.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethylbenzene
DOT Hazard Class: 3
ID No.: UN1175
DOT Packing Group: II
DOT Label: Flammable liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60 L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: —

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 153, 159, 162, 163, 164, 167, 168, 171, 176, 179
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheet Collection

Methanol

MSDS No. 354

Date of Preparation: 11/77 Revision: E, 3/98

Section 1 - Chemical Product and Company Identification 51

Product/Chemical Name: Methanol **Chemical Formula:** CH_4O or CH_3OH **CAS Number:** 67-56-1

Synonyms: carbinol; Coat-B1400; Colonial Spirits; Columbian Spirit; EPA pesticide chemical code 053801; methyl alcohol; methyl hydrate; methyl hydroxide; monohydroxymethane; pyroligneous spirit; pyroxylic spirit; pyroxylic spirits; Surflo-B17; wood alcohol; wood naphtha; wood spirit

Derivation: Prepared by wood pyrolysis; non-catalytic oxidation of hydrocarbons; as a by-product in the fisher-tropsch synthesis; or by reduction of carbon monoxide.

General Use: Used as an industrial solvent; starting material for organic synthesis; antifreeze for windshield washer fluid; in fuel antifreezes; gasoline octane booster; fuel for stoves; extractant for oils; denaturing ethanol; softening agent; food additive; in paint, varnish removers, and embalming fluids; in the manufacture of photographic film, celluloid, textile soap, wood stains, coated fabrics, shatterproof glass, paper coating, waterproofing formulations, artificial leather, dyes.

Vendors: Consult the latest *Chemical Week Buyers' Guide*. (73)

Section 2 - Composition / Information on Ingredients

Methanol, ca 100% vol

Trace Impurities (Grade A): Acetone and aldehydes < 30 ppm, acetic acid < 30 ppm

OSHA PELs
8- hr TWA: 200 ppm (260 mg/m^3)
Vacated 1989 Final Rule Limits:
TWA: 200 ppm (260 mg/m^3)
STEL: 250 ppm (325 mg/m^3)

ACGIH TLVs*
TWA: 200 ppm (262 mg/m^3), *Skin*
STEL: 250 ppm (328 mg/m^3)

NIOSH REL
10- hr TWA: 200 ppm (260 mg/m^3), *Skin*
STEL: 250 ppm (325 mg/m^3)

IDLH Level
6000 ppm

DFG (Germany) MAK
TWA: 200 ppm (260 mg/m^3), *Skin*
Category II, 1: Substances with systemic effects; onset of effect ≤ 2 hr; half life < 2 hr
Embryo/Fetus Risk of Damage Classification C†

Peak Exposure Limit:
400 ppm (520 mg/m^3), 30 min, average value. 4/shift

*There are also ACGIH Biological Exposure Indices (BEIs™).

†There is no reason to fear risk of damage to developing embryo or fetus when MAK or BAT values are observed.

Section 3 - Hazards Identification

ANSI Signal Word: Warning!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Methanol is a colorless liquid with a slight alcohol odor when pure, or disagreeably pungent odor when crude. It is irritating to the eyes, skin, and respiratory tract. Exposure may result in headache, visual disturbance, blindness, and respiratory failure. Reproductive effects have been reported in animal testing. This flammable liquid is a moderate explosion hazard. When heated to decomposition, methanol emits carbon oxides (CO_x), formaldehyde, acrid smoke, and irritating fumes.

Wilson Risk Scale	
R	1
I	3
S	2*
K	3

*Skin absorption

HMIS	
H	2*
F	3
R	0
PPE†	

*Chronic effects
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin and/or eye contact/absorption

Target Organs: Eyes, skin, central nervous system (CNS), gastrointestinal (GI) tract, respiratory system

Acute Effects

Inhalation: Irritation, breathing difficulty, headache, drowsiness, vertigo, light-headedness, nausea, vomiting, acidosis (decreased blood alkalinity), visual disturbance, and at high concentrations, CNS damage, convulsions, circulatory collapse, respiratory failure, coma and blindness can result from inhalation of methanol vapor. Concentration ≥ 200 ppm may cause headache; 50,000 ppm can cause death within 1-2 hrs. **Eye:** Contact with liquid may result in irritation, inflamed lids, light sensitization, and superficial lesions. **Skin:** Contact may cause irritation, dermatitis, swelling, scaling, and systemic effects listed under inhalation. **Ingestion:** GI irritation and systemic effects (see Inhalation). Symptoms may be delayed 18-48 hours. Fatal dose: 2-8 ounces.

Carcinogenicity: IARC, NTP, and OSHA do not list methanol as a carcinogen. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Chronic Effects:** Exposure to methanol vapors has caused conjunctivitis, headache, giddiness, insomnia, GI disturbance, impaired vision. CNS damage is also likely. Methanol is slowly eliminated from the body; exposure is considered cumulative over the short term.

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Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed. **Eye Contact:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain or irritation develops. **Skin Contact:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. ***After first aid, get appropriate in-plant, paramedic, or community medical support.*** **Note to Physicians:** Follow emesis with rehydration, correction of acidosis, and folate to enhance formate oxidation. Consider IV administration of ethanol (if blood methanol >20 mg/dL) to show metabolic oxidation of methanol. Assay formic acid in urine, blood pH and plasma bicarbonate.

Section 5 - Fire-Fighting Measures

Flash Point: 54 °F (12 °C) **Flash Point Method:** CC **Burning Rate:** 1.7 mm/min
Autoignition Temperature: 867 °F (464 °C) **LEL:** 6.0% v/v **UEL:** 36% v/v
Flammability Classification: OSHA Class IB Flammable Liquid.

NFPA



Extinguishing Media: Use dry chemical, carbon dioxide, water spray, fog or alcohol-resistant foam. A water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources. **Unusual Fire or Explosion Hazards:** Can form explosive mixtures in the air. The heavier-than-air vapors of methanol may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire. **Hazardous Combustion Products:** Heating methanol to decomposition can produce carbon oxides (CO_x), formaldehyde, acrid smoke, and irritating fumes. **Fire-Fighting Instructions:** *Do not* scatter material with any more water than needed to extinguish fire. *Do not* release runoff from fire control methods to sewers or waterways. **Fire-Fighting Equipment:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Isolate spill area for at least 330-660 feet (100-200 m) in all directions. Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Ground all equipment used when handling this product. *Do not* touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A vapor suppressing foam may be used to reduce vapors. **Small Spills:** Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Use clean non-sparking tools to collect absorbed material. **Large Spills, Containment:** Dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways. **Cleanup:** Ground all equipment. Use non-sparking tools. **Regulatory Requirements:** Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves, goggles, and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers. **Storage Requirements:** Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors. **Regulatory Requirements:** Follow applicable OSHA regulations (29 CFR 1910.106) for Class 1B Flammable Liquids.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. **Ventilation:** Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. **Administrative Controls:** Enclose operations and/or provide local explosion-proof exhaust ventilation at the site of chemical release. Where possible, transfer methanol from drums or other storage containers to process containers. Minimize sources of ignition in surrounding areas. **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations ≤ 2000 ppm, use a supplied air respirator; ≤ 5000 ppm, supplied air (SA) respirator in continuous flow mode; ≤ 6000 ppm, SA respirator with tight-fitting face mask operated in continuous flow mode, or SCBA with full facepiece, or SA respirator with full facepiece; > IDLH/unknown/emergency, SCBA with full facepiece operated in pressure-demand or other positive-pressure mode, or SA respirator with full facepiece operated in pressure-demand

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or other positive-pressure mode in combination with auxiliary SCBA operated in pressure-demand or other positive-pressure mode. For escape, use an appropriate escape-type SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Wear chemically protective gloves, boots, aprons, and gauntlets of butyl rubber, Teflon™, Viton™, Saranex™, 4H™, Responder™, Trellchem HPS™, or Tychem 10000™ (Breakthrough Time (BT) >8 hr) to prevent skin contact. Natural rubber, neoprene, nitrile rubber, polyethylene, polyvinyl alcohol and CPF 3™ may degrade after contact and are not recommended. Wear splash-proof chemical safety goggles, and face shield, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, washing facilities available in work area. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Colorless; slight alcohol odor when pure, disagreeably pungent odor when crude
Odor Threshold Range: 13.1150 to 26840 mg/m^3
Vapor Pressure: 127 mm Hg at 77 °F (25 °C)
Vapor Density (Air=1): 1.11
Saturated Vapor Density (air=1.2 kg/m^3, 0.075 lb./ft^3): 1.221 kg/m^3
Formula Weight: 32.04
Density: 0.796 g/mL at 59 °F (15 °C)
Specific Gravity (H_2O=1, at 4 °C): 0.81 at 0 °C/4 °C
Bulk Density: 6.59 lbs/gal at 68 F (20 °C)
pH: Slightly acidic
Water Solubility: Miscible
Other Solubilities: Ethanol, acetone, benzene, chloroform, DMSO, ether, ketones, most organic solvents.
Boiling Point: 148 °F (64.7 °C) at 760 mm Hg
Freezing Point: -144.04 °F (-97.8 °C)
Viscosity: 0.614 mPa sec
Refractive Index: 1.3292 at 68 °F (20 °C)/D
Surface Tension: 22.61 dynes/cm
Ionization Potential (eV): 10.84
Henry's Law Constant (H): 4.55 x10^{-6} atm-m^3/mole at 77 °F (25 °C)
Octanol/Water Partition Coefficient: log K_{ow} = -0.77
Soil Sorption Coefficient (log K_{oc}): 0.44

Section 10 - Stability and Reactivity

Stability: Methanol is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include beryllium dihydride, metals (potassium, magnesium), oxidants (barium perchlorate, bromine, chlorine, hydrogen peroxide, sodium hypochlorite, phosphorus trioxide), potassium tertbutoxide, carbon tetrachloride and metals, chloroform and heat, diethyl zinc, alkyl aluminum salts, acetyl bromide, chloroform and sodium hydroxide, cyanuric chloride, nitric acid, chromic anhydride, lead perchlorate.
Conditions to Avoid: Vapor inhalation, oxidizers. **Hazardous Decomposition Products:** Thermal oxidative decomposition of methanol can produce carbon oxides (CO_x), formaldehyde, acrid smoke, and irritating fumes.

Section 11- Toxicological Information

Toxicity Data:*

Reproductive Effects:
Rat (female), oral: 7500 mg/kg, administered during gestational days 17-19 produced effects on newborn - behavioral.
Rat (female), oral: 35295 mg/kg administered during gestational days 1-15 produced effects on the fertility index; pre-implantation mortality; and post-implantation mortality.
Rat (female), inhalation: 20000 ppm/7 hr, administered during gestational days 1-22 produced specific developmental abnormalities - musculoskeletal system; cardiovascular (circulatory) system; urogenital system.
Rat (male), oral: 200 ppm/20 hr, 78 weeks prior to mating produced paternal effects - testes, epididymis, sperm duct.
Multiple Dose Toxicity Data:
Rat, oral: 12 g/kg/8 weeks intermittently produced toxic effects: behavioral - ataxia; behavioral - alteration of operant conditioning.
Rat, inhalation: 50 mg/m^3/12 hr/13 weeks intermittently produced degenerative changes to brain and coverings; muscle contraction or spasticity.
Rat, inhalation: 2610 ppm/6 hr/4 weeks intermittently produced toxic effects: endocrine - changes in spleen weight.
Eye Effects:
Rabbit, standard Draize test: 100 mg/24 hr resulted in moderate irritation.

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Section 11- Toxicological Information, continued

Toxicity Data:*

Skin Effects:
Rabbit, standard Draize test: 20 mg/24 hr resulted in moderate irritation.

Acute Oral Effects:
Human, oral, LD_{Lo}: 428 mg/kg produced toxic effects: behavioral - headache; lungs, thorax, or respiration - other changes.
Human, oral, LD_{Lo}: 143 mg/kg produced optic nerve neuropathy, dyspnea, nausea or vomiting.
Rat, oral, LD_{50}: 5628 mg/kg

Acute Dermal Effects:
Monkey, skin, LD_{Lo}: 393 mg/kg
Rabbit, skin, LD_{50}: 15800 mg/kg

Acute Inhalation Effects:
Human, inhalation, TC_{Lo}: 300 ppm produced visual field changes, headache; lungs, thorax, or respiration - other changes.
Rat, inhalation, LC_{50}: 64000 ppm/4 hr

Mutagenicity:
Human, lymphocyte: 300 mmol/L resulted in DNA inhibition.
Rat, oral: 10 µmol/kg resulted in DNA damage.

* See NIOSH, *RTECS* (PC1400000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Trout, LC_{50}: 8,000 mg/L/48 hr; *Pimephales promelas* (fathead minnow) LC_{50}: 29.4 g/L/96 hr.
Environmental Fate: Bioconcentration (BCF, estimated at 0.2) is not expected to be significant. Physical removal from air can occur via rainfall. Relatively rapid evaporation from dry surfaces is likely to occur.
Environmental Degradation: If released to the atmosphere, it degrades via reaction with photochemically produced hydroxyl radicals with an approximate half-life of 17.8 days. If released to water or soil, biodegradation is expected to occur.
Soil Adsorption/Mobility: A low Koc indicates little sorption and high mobility in the soil column.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Methanol
Shipping Symbols: D
Hazard Class: 3
ID No.: UN1230
Packing Group: II
Label: FLAMMABLE LIQUID
Special Provisions (172.102): T*

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 1 L
b) Cargo Aircraft Only: 60 L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
Listed and Classified as a RCRA Hazardous Waste (40 CFR 261.33): Characteristic of Ignitability
RCRA Hazardous Waste Number: U154
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per (3) CAA, Sec. 112; (4) RCRA, Sec. 3001
CERCLA Final Reportable Quantity (RQ), 5000 lb (2268 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 1, 73, 99, 103, 124, 136, 149, 176, 190, 209, 216, 217, 218, 222, 223, 224, 227, 228, 230
Prepared By..... HM Spliethoff, MS
Industrial Hygiene Review..... PA Roy, MPH, CIH
Medical Review..... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection

Naphthalene

MSDS No. 624

Date of Preparation: 11/87 Revision: A, 9/97

Section 1 - Chemical Product and Company Identification 50

Product/Chemical Name: Naphthalene
Chemical Formula: $C_{10}H_8$
CAS Number: 91-20-3
Synonyms: Albocarbon; camphor tar; Dezodorator; Mighty 150; moth balls; moth flakes; naftalen (Polish); naphthalin; naphthaline; naphthalinum; naphthene; NTM; tar camphor; white tar
Derivation: From coal tar; from petroleum fractions after various catalytic processing operations.
General Use: Used as a moth repellent, an antiseptic, toilet bowl deodorant, heat transfer agent, fungicide, smokeless powder, cutting fluid, lubricant, wood preservative; an intermediate for naphthol, phthalic anhydride, chlorinated naphthalenes, Tertralin, Decalin, naphthyl and naphthol derivatives, and dyes; in synthetic resins, synthetic tanning, textile chemicals, scintillation counters, and emulsion breakers.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Naphthalene, ca 100% wt. Grade: By melting point, 165 °F (74 °C) min (crude) to greater than 174 °F (79 °C) (refined); scintillation 176-177 °F (80-81 °C)

OSHA PELs	ACGIH TLVs	NIOSH RELs	IDLH Level
8-hr TWA: 10 ppm (50 mg/m^3); *Vacated 1989 Final Rule Limit:* 15-min. STEL: 15 ppm (79 mg/m^3)	TWA: 10 ppm (52 mg/m^3) STEL: 15 ppm (79 mg/m^3)	10-hr TWA: 10 ppm (50 mg/m^3); 15-min. STEL: 15 ppm (75 mg/m^3)	500 ppm

DFG (Germany) MAK
10 ppm (50 mg/m^3)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Naphthalene is a white crystalline solid with a 'moth ball' or coal-tar odor. It is toxic by ingestion. Irritating to skin, eyes, and respiratory system. Naphthalene is a combustible solid. Dust may form explosive mixtures in air if subjected to an ignition source.

Wilson Risk Scale	
R	1
I	3
S	2*
K	2

*Skin absorption

HMIS	
H	2†
F	2
R	0
PPE‡	

†Chronic Effects
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin absorption, skin and/or eye contact
Target Organs: Blood (red blood cell effects), eyes, skin, central nervous system (CNS), liver and kidneys
Acute Effects
Inhalation: Vapor inhalation causes headache, confusion, nausea, sometimes vomiting, loss of appetite, extensive sweating, dysuria (painful urination), hematuria (blood in the urine), and hemolysis (destruction of red blood cells).
Eye: Irritation, conjunctivitis, and corneal injury upon prolonged contact.
Skin: Irritation and hypersensitivity dermatitis.
Ingestion: Unlikely. However, ingestion causes irritation of the mouth and stomach, hemolytic anemia with hepatic and renal lesions and vesical congestion, kidney failure, hematuria, jaundice, depression of CNS, nausea, vomiting, abdominal pain, blue face, lips, or hands, rapid and difficult breathing, headache, confusion, excitement, malaise, fever, perspiration, urinary tract pain, dizziness, convulsions, coma, and death. Symptoms may appear 2 to 4 hours after exposure.
Carcinogenicity: IARC, NTP, and OSHA do not list naphthalene as a carcinogen. EPA-D, Not Classifiable as to Human Carcinogenicity; MAK-B, Justifiably suspected of having carcinogenic potential; TLV-A4, Not Classifiable as a Human Carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Diseases of the blood, liver and kidneys; individuals with a hereditary deficiency of the enzyme glucose-6-phosphate dehydrogenase in red blood cells are particularly susceptible to the hemolytic properties of naphthalene metabolites.
Chronic Effects: May cause optical neuritis, corneal injuries, cataracts, kidney damage.
Other: There are two reports of naphthalene crossing the placenta in humans.

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Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed. Contact a physician immediately if symptoms of systemic poisoning are present.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist if pain, irritation, swelling, or photophobia persist.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area thoroughly with soap and water. For reddened or blistered skin, consult a physician. Contact a physician immediately if symptoms of systemic poisoning are present.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Contact a physician immediately.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Obtain baseline CBC, electrolytes, liver and renal function rests, glucose-6-phosphatase dehydrogenase level, urinalysis, and benzidine dipstick to check for hemoglobinuria. Urinary metabolite, 1-naphthol or mercapturic acid, may help confirm the diagnosis.

Section 5 - Fire-Fighting Measures

Flash Point: 174 °F (79 °C); 190 °F (88 °C)
Flash Point Method: OC; CC
Burning Rate: Data not found.
Autoignition Temperature: 979 °F (526 °C)
LEL: 0.9% v/v
UEL: 5.9% v/v
Flammability Classification: Combustible solid

NFPA



Extinguishing Media: Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water or foam may cause frothing. Use water spray to keep fire-exposed containers cool.

Unusual Fire or Explosion Hazards: Volatile solid that gives off flammable vapors when heated. Dust may explode in air if an ignition source is provided.

Hazardous Combustion Products: Toxic vapors including carbon monoxide.

Fire-Fighting Instructions: Move containers from the fire area if it can be done without risk. Otherwise cool fire-exposed containers until well after the fire is extinguished. *Do not* release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Wear full protective clothing (see Sec. 8). Structural clothing is permeable, remain clear of smoke, water fall out, and water run off.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources. Isolate and ventilate area, deny entry, stay upwind. Stop leak if you can do it without risk. Use spark-proof tools and explosion proof equipment. Cleanup personnel should wear personal protective equipment to protect against exposure (see Sec. 8).

Small Spills: *Do not* sweep! Carefully scoop up or vacuum (with a HEPA filter). Absorb liquid spill with an inert, noncombustible absorbent such as sand or vermiculite.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: To avoid vapor inhalation use only with ventilation sufficient to reduce airborne concentrations to nonhazardous levels. Avoid skin and eye contact. Wear personal protective clothing and equipment to prevent any contact with skin and eyes (see Sec. 8). Practice good personal hygiene procedures to prevent inadvertently ingesting this material.

Storage Requirements: Store in tightly closed, explosion-proof containers in a cool, well-ventilated area away from heat, ignition sources, and incompatibles (see Sec. 10). May be stored under nitrogen gas. Protect containers against physical damage. Use monitoring equipment to measure the extent of vapor present in any storage facility containing naphthalene because of potential fire and explosion hazards.

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Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose operations to avoid vapor and dust dispersion into the work area. Ventilate at the site of chemical release. During the fractional distillation of naphthalene and in any operation entailing the heating or volatilization of naphthalene, enclosed apparatus should be employed.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Educate workers about the health and safety hazards associated with naphthalene. Train in work practices which minimize exposure. Consider preplacement and periodic medical exams with emphasis on the eyes, skin, liver, kidneys, CBC (RBC count, WBC count, differential count of a stained smear, hemoglobin, and hematocrit), and urinalysis including at a minimum specific gravity, albumin, glucose, and a microscopic examination on centrifuged sediment.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Teflon® is recommended. *Do not* use butyl rubber, natural rubber, neoprene or polyvinyl chloride. Wear chemical dust-proof safety goggles and face shield, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove naphthalene from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Crystalline solid

Appearance and Odor: White, volatile flakes, cakes, cubes, spheres, or powder; strong coal-tar or moth ball odor

Odor Threshold: 0.084 ppm to 0.3 ppm

Vapor Pressure: 0.05 mm Hg at 68 °F (20 °C); 1.0 mm Hg at 127 °F (53 °C)

Formula Weight: 128.2

Density: 1.145 g/cm^3 at 68 °F (20 °C)

Saturated Vapor Concentration: 100 ppm at 77 °F (25 °C) (approx.)

Water Solubility: Insoluble [31.7 mg/L at 68 °F (20 °C)]

Other Solubilities: Benzene, absolute alcohol; very soluble in ether, chloroform, carbon disulfide, hydronaphthalenes, fixed and volatile oils

Boiling Point: 424 °F (218 °C)

Melting Point: 176 °F (80.2 °C)

Volatility: Volatilizes appreciably at room temperature; volatile with steam

Octanol/Water Partition Coefficient: log K_{ow} = 3.30

Section 10 - Stability and Reactivity

Stability: Naphthalene is stable at room temperature in closed containers under normal storage and handling conditions. It volatilizes at room temperature.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include aluminum chloride, benzoyl chloride, chromic acid, chromium trioxide, oxidizers. Explosive reaction with dinitrogen pentaoxide. Melted naphthalene will attack some forms of plastics.

Conditions to Avoid: Exposure to heat and ignition sources, incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of naphthalene can produce toxic fumes including carbon monoxide.

Section 11- Toxicological Information

Toxicity Data:*

Acute Effects:

Human (child), oral, LD_{Lo}: 100 mg/kg

Man, unreported, LD_{Lo}: 74 mg/kg

Rat, oral, LD_{50}: 490 mg/kg

Reproductive Effects:

Rat, oral: 4500 mg/kg administered on gestational days 6-15 produced fetotoxicity and other developmental abnormalities.

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Section 11- Toxicological Information, *continued*

Toxicity Data:*

Acute Effects: *continued*
Mouse, oral, LD_{50}: 533 mg/kg
Rat, inhalation, LC_{50}: >340 mg/m^3 produced lacrimation and somnolence.
Genetic Effects:
Hamster, ovary: 15 mg/L induced sister chromatid exchange.

Tumorigenicity:
Mouse, inhalation: 30 ppm/6 hr/2 yr administered intermittently produced toxic effects: tumorigenic - neoplastic by RTECS criteria; lungs, thorax, or respiration - tumors.
Skin Effects:
Rabbit, skin, open Draize test: 495 mg produced mild irritation.
Eye Effects:
Rabbit, eye, standard Draize test: 100 mg produced mild irritation.

*See *NIOSH RTECS* (QJ0525000) for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: *Oncorhynchus gorbuscha* (pink salmon): 1.37 ppm/96 hr at 39 °F (4 °C). *Pimephales promelas* (fathead minnow): 7.76 mg/L/24 hr.
Environmental Fate: If released to the atmosphere, naphthalene rapidly photodegrades with a half-life of 3-8 hr. Volatilization, photolysis, adsorption, and biodegradation are important loss mechanisms for naphthalene discharged into water. Depending on local conditions, the half-lives range from a couple of days to a few months. If released on land, it is adsorbed moderately to soil, undergoes biodegradation; but in some cases biodegradation may still occur if conditions are aerobic. Bioconcentration occurs to a moderate extent, but is a temporary problem since depuration and metabolism readily proceed in aquatic organisms.

Section 13 - Disposal Considerations

Disposal: Consider rotary kiln or fluidized bed incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
Container Cleaning and Disposal: Handle empty containers carefully as hazardous residues may still remain.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Naphthalene, crude or Naphthalene, refined
Shipping Symbols: Not listed
Hazard Class: 4.1
ID No.: UN1334
Packing Group: III
Label: FLAMMABLE SOLID
Special Provisions (172.102): A1

Packaging Authorizations
a) Exceptions: 173.151
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 25 kg
b) Cargo Aircraft Only: 100 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: Not listed

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33). Hazardous Waste Number: U165
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307(a); CAA, Sec. 112
CERCLA Final Reportable Quantity (RQ), 100 lb (45.4 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 99, 103, 124, 139, 140, 167, 168, 179, 190, 196, 197, 200, 220 PC-W6

Prepared By .....S Fleming, BS/MJ Wurth, BS
Industrial Hygiene Review.....DJ Wilson, CIH
Medical Review.....G Kelafant, MD

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Material Safety Data Sheets Collection:

Sheet No. 355
Phenol

Issued: 9/80 Revision: C, 11/90

Section 1. Material Identification

33

Phenol (C_6H_5OH) Description: One of many aromatic compounds in coal tar. Made by alkylating benzene with propylene then oxidizing the resulting cumene to produce phenol and acetone. Used as a feedstock in manufacturing various phenolic resins, caprolactum, bis-phenol-A, and other chemicals and drugs; a disinfectant; a fuel-oil sludge inhibitor; a reagent in chemical analysis; in producing or manufacturing a large variety of aromatic compounds including fertilizers, illuminating gas, coke, explosives, lampblack, paints, paint removers, asbestos goods, wood preservatives, textiles, perfumes, bakelite, rubber, and other plastics; in medical and industrial organic compounds and dyes; and in germicidal paints and slimicides. Phenol has been identified in cigarette smoke and automobile exhaust.
Other Designations: CAS No. 0108-95-2, carbolic acid, hydroxybenzene, monohydroxy benzene, oxybenzene, phenic acid, phenyl alcohol, phenyl hydroxide.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 1
I 4
S 3*
K 2
* Skin absorption

NFPA
2
3 0
-

HMIS
H 3
F 2
R 0
PPG†
† Sec. 8

Cautions: Phenol has a marked corrosive effect on any tissue. Eye contact may cause severe damage and *blindness*. Its primary entry route is through *skin absorption*. Systemic absorption may cause *liver and kidney damage, convulsions (seizures), or death.*

Section 2. Ingredients and Occupational Exposure Limits

Phenol, ca 100%

1989 OSHA PEL (Skin)
8-hr TWA: 5 ppm, 19 mg/m³

1990-91 ACGIH TLV (Skin)
TWA: 5 ppm, 19 mg/m³

1988 NIOSH REL
TWA: 5 ppm, 19 mg/m³
Ceiling: 15.6 ppm, 60 mg/m³

1985-86 Toxicity Data*
Mammal, inhalation, LC_{50}: 74 mg/m³
Rat, oral, LD_{50}: 317 mg/kg; toxic effects include behavorial changes (convulsions or effect on seizure threshold)
Rabbit, eye, TC_{Lo}: 5 mg produces severe irritation

1987 IDLH Level
250 ppm

* See NIOSH, *RTECS* (SJ3325000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 359.15 °F (181.75 °C) at 760 mm Hg
Melting Point: 109.4 °F (43 °C)
Vapor Pressure: 0.3513 mm Hg at 77 °F (25 °C)
Vapor Density (Air = 1): 3.24
pH: 6 (aqueous solution)
Molecular Weight: 94.11
Specific Gravity (20 °C/4 °C): 1.0576
Water Solubility: 1 g dissolves in about 15 ml H_2O
Viscosity: 12.7 centipoise at 64.9 °F (18.3 °C)

Appearance and Odor: White crystalline solid with a characteristic sharp medicinal sweet, tangy odor detectable above 0.05 ppm. Phenol turns pink or red if it contains impurities or is exposed to heat or light.

Section 4. Fire and Explosion Data

Flash Point: 175 °F (79 °C), CC	Autoignition Temperature: 1319 °F (715 °C)	LEL: 1.7% v/v	UEL: 8.6% v/v

Extinguishing Media: Use water spray, carbon dioxide, dry chemical, or alcohol-type foam to extinguish fires involving phenol. Do not use a solid stream of water since the stream scatters and spreads fire. Use water spray to cool fire-exposed tanks/containers.
Unusual Fire or Explosion Hazards: Phenol presents a moderate fire hazard when exposed to heat, flame, or oxidizers. When heated, it emits toxic fumes and vapors that form explosive mixtures with air. Air mixtures containing 3 to 10% phenol are explosive. Solid phenol burns with difficulty, giving off heavy smoke.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. Be aware of runoff from fire control methods. Water containing phenol can cause severe chemical burns. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Phenol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: In general, phenol is incompatible with strong oxidizing agents and halogens. It coagulates colodion and proteins. A potentially explosive reaction occurs with formaldehyde, peroxydisulfuric acid, peroxymonosulfuric acid, sodium nitrite + heat, and aluminum chloride + nitromethane (at 110 °C/100 bar). A violent reaction occurs with butadiene, sodium nitrite + trifluoroacetic acid, and aluminum chloride + nitrobenzene at 248 °F (120 °C). Combining phenol with mineral oxidizing acids results in fire; with acetaldehyde results in violent condensation; with isocyanates results in heat generation and violent polymerization, with calcium hypochlorite results in an exothermic reaction producing toxic fumes which may ignite; and with nitrides results in heat and flammable gas generation. Hot phenol is corrosive to many metals, including aluminum, lead, magnesium, and zinc. Reaction with these materials causes phenol to discolor.
Conditions to Avoid: Avoid heating phenol above 122 °F (90 °C).
Hazardous Products of Decomposition: Thermal oxidative decomposition of phenol can produce oxides of carbon and water.

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list phenol as a carcinogen. Although no specific evidence of human cancer exists, its carcinogenicity to mice emphasizes the need for precaution when handling this material. Phenol also causes human mutations (genetic changes).
Summary of Risks: Phenol is a general protoplasmic poison that is corrosive to any living tissue it contacts. Toxicity most likely results from dermal (skin) contact or ingestion. Skin absorption occurs readily with a rapid onset of symptoms or death (within 30 min to several hours). Contact with eyes may cause severe damage and blindness. Ingestion of 1 g may be fatal. Although phenol is irritating to the respiratory tract, due to its low volatility and good warning properties, inhalation is typically less of a concern. Chronic toxic effects are uncommon, but may include digestive disturbances, neurological disorders, skin rash (dermatitis), and liver and kidney damage.
Medical Conditions Aggravated by Long-Term Exposure: Individuals with chronic respiratory disorders, pre-existing skin disorders, convulsive disorders, or kidney or liver abnormalities may be at increased risk from phenol exposure.
Target Organs: Liver, kidneys, nervous system, and skin.
Primary Entry Routes: Skin absorption, eye contact, ingestion, and inhalation.
Acute Effects: Skin contact results in white, wrinkled discoloration, followed by a severe burn or systemic poisoning if removed improperly.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Phenol ingestion can cause gangrene and corrosion of lips, mouth, throat, esophagus, and stomach if not properly decontaminated (see First Aid). Although not immediately painful, skin contact can cause serious burns and systemic toxicity. In addition to skin burns and respiratory tract irritation, systemic absorption may cause pallor, anorexia (appetite loss), nausea, vomiting, diarrhea, weakness, muscle aches, darkened urine, headache, tinnitus (ringing in ears), sweating, convulsions, cyanosis (bluish coloration of lips and/or fingertips), shock, unconsciousness, respiratory failure, and death. After ingestion, major percutaneous (skin), or inhalation exposures, collapse and death can be rapid. Ingestion can cause severe tissue corrosion or gangrene affecting lips, mouth, throat, esophagus, and stomach. Eye contact can cause severe corrosive damage to the eye (conjunctival edema, corneal opacification, and hypesthesia) and possible blindness.

Chronic Effects: Chronic phenol poisoning is rarely reported. Symptoms include vomiting, difficulty swallowing, diarrhea, appetite loss, headache, fainting, dizziness, darkened urine, and mental disturbances. Chronic exposure can cause death from liver and kidney damage. Repeated skin contact with phenol or phenol-bearing products can result in dermatitis with dark pigmentation (ochronosis) of skin and whites of eyes (sclerae).

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician immediately.

Skin: Speedy action is critical. Flood exposed area with water and quickly remove contaminated clothing. *As soon as possible*, repeatedly spray or swab with the decontaminating agent polyethyleneglycol-300 (PEG). Immerse extremities in PEG. Rescue personnel should protect themselves from skin contact with phenol. Do not use greases, powders, or ointments to treat phenol burns. *Never* delay phenol removal if PEG is not readily available. Use soap and water instead.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: *Speed is essential in the treatment of oral poisoning.* Immediately consult a physician and poison center. Never give anything by mouth to an unconscious or convulsing person. Administer to that *conscious* person 15 to 30 cc castor oil or another vegetable oil, and be prepared to induce vomiting upon a physician's advice. Vegetable oils slow phenol absorption and reduce local damage.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treat ingestion with gastric lavage using 40% aqueous Bacto-Peptone, milk, or water until phenolic odor is eliminated. Then give 15 to 50 cc castor or vegetable oil. Debride necrotic skin. Monitor vital signs, fluid status, electrolytes, BUN, renal and hepatic function, and electrocardiogram. Manage sedation, seizures, renal failure, and fluid electrolyte imbalances symptomatically as indicated.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and skin and eye contact with a self-contained breathing apparatus and full personal protective clothing and equipment. Absorb small spills with some noncombustible inert material and place in a closed metal container for disposal. Dike large spills and allow material to cool and solidify. Using nonsparking tools, shovel solid into steel containers for disposal. Thoroughly flush spill area with water, use caustic soda solution for neutralization, and collect flushings and wash water for disposal. Do not allow phenol to enter sewers, watersheds, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120). Notify proper authorities including the National Response Center (800-424-8802).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4), Sec. 307(a), and per RCRA, Sec. 3001]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355): RQ, 1000 lb; Threshold Planning Quantity (TPQ), 500/10,000 lb

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Where potential exists for exposures near or over 19 mg/m³, use a MSHA/NIOSH-approved full facepiece respirator with an organic vapor cartridge/canister and dust/mist prefilter. Increased protection is obtained from full facepiece powered-air purifying respirators. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. ACGIH recommends neoprene or butyl rubber as good-to-excellent protective materials.

Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heated surfaces, open flame, and ignition sources. Outside or detached storage is preferred. Protect containers from physical damage.

Engineering Controls: Enclose all operations, eliminating all possible phenol exposure routes. Educate workers about phenol's hazards and potential dangers. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Provide local exhaust ventilation at the site of chemical release. Practice good personal hygiene and housekeeping procedures.

Medical Surveillance: Provide preplacement or periodic medical examinations that emphasize central nervous system (CNS), hepatic, renal, and skin. Tests should include BUN, creatinine, LFTs, and urinalysis. Phenol can be detected in urine in free or conjugated forms. The ACGIH biological exposure index (BEI) is 250 mg total phenol/g creatinine or 15 mg/hr.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Phenol
DOT Hazard Class: Poison B
ID No.: UN1671
DOT Label: Poison
DOT Packaging Exceptions: 173.364
DOT Packaging Requirements: 173.369

IMO Shipping Name: Phenol
IMO Hazard Class: 6.1
ID No.: UN1671
IMO Label: Poison
IMDG Packaging Group: II

MSDS Collection **References:** 1, 2-12, 15, 19, 23, 24, 26, 31, 34, 37, 38, 59, 73, 79, 84, 85, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138-140, 143, 146, 148, 149

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:
Sheet No. 351
Styrene *monomer*
Issued: 8/79 Revision: D, 6/92

Section 1. Material Identification

Styrene *monomer* ($C_6H_5CHCH_2$) **Description:** Produced by catalytic dehydrogenation of ethylbenzene at 932 to 1292 °F (500 to 700 °C) at 30 mm Hg; catalyst is a mixture of zinc oxide (86%), aluminum, calcium, and magnesium. Available in technical (99.2% pure) and polymer (99.6% pure) grades. Occurs naturally in the sap of styracaceous plants, in pyrolysis and cracking products of petroleum derivatives, in bituminous-coal and shale-oil tars, in rubber latexes, and as a product of organic substance pyrolysis. Used in the manufacture of a wide range of polymers including polystyrene and copolymer elastomers such as butadiene-styrene rubber or acrylonitrile-butadiene-styrene (ABS); in production of plastics and insulators, as a resin modifying additive, dental filling component, chemical reaction intermediate, and in agricultural products.
Other Designations: CAS No. 100-42-5, cinnamene, Diarex HF 77, ethenylbenzene, NCI-C02200, phenylethylene, styrol, styropor, vinylbenzene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Styrene is extremely flammable and polymerizes easily. The vapor is irritating to eyes, skin, and respiratory system and the liquid may cause burns. Inhalation of high concentrations can lead to central nervous system (CNS) depression.

R 2
I 3
S 2*
K 3
* Skin absorption

NFPA†



HMIS
H 2
F 3
R 2
PPG‡
‡ Sec. 8

† Rating is for *inhibited* monomer

Section 2. Ingredients and Occupational Exposure Limits

Styrene *monomer*, ca 99.6%, containing inhibitors butylcatechol or hydroquinone

1991 OSHA PELs
8-hr TWA: 50 ppm (215 mg/m³)
15-min STEL: 100 ppm (425 mg/m³)

1990 IDLH Level
5000 ppm

1990 NIOSH RELs
TWA: 50 ppm (215 mg/m³)
STEL: 100 ppm (425 mg/m³)

1991-92 ACGIH TLVs (Skin)
TWA: 50 ppm (213 mg/m³)
STEL: 100 ppm (426 mg/m³)

1990 DFG (Germany) MAKs
Ceiling: 20 ppm (85 mg/m³)
Half-life: < 2 hr
Peak Exposure Limit: 40 ppm, 30 min. average value, 4 per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 20 µg/m³ caused eye effects.
Human, skin: 500 mg (non-standard test, *accident*) caused irritation.
Human, HeLa cell: 28 mmol/L caused unscheduled DNA synthesis.
Rat, oral, LD_{50}: 5000 mg/kg; toxic effects not yet reviewed
Rat, inhalation, LC_{50}: 24 g/m³/ 4 hr produced an antipsychotic effect.

* See NIOSH, *RTECS* (WL3675000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 293 °F (145 °C)
Freezing Point: -23 °F (-31 °C)
Vapor Pressure: 5 mm Hg at 68 °F (20 °C)
Viscosity: 0.751 mPa
Refraction Index: 1.5463 at 68 °F (20 °C)
Odor Threshold Range: 0.15 to 25 ppm
Density: 0.9045 at 25/25 °C
Surface Tension: 32.14 dyne/cm at 66.2 °F (19 °C)
Molecular Weight: 104.2
Saturated Vapor Density (air = 1.2 kg/m³): 1.22 kg/m³ or 0.076 lbs/ft³
Water Solubility: Practically insoluble, 0.3 lbs/100 lbs water; floats on water
Other Solubilities: Soluble in benzene, carbon disulfide, carbon tetrachloride, ethanol, ethyl ether and ketones. Dissolves organic substances and polymers.

Appearance and Odor: Colorless to slightly yellow oily liquid with a sweet, pleasant odor at low levels becoming pungent as levels increase.

Section 4. Fire and Explosion Data

Flash Point: 88 °F (31 °C), CC	Autoignition Temperature: 914 °F (490 °C)	LEL: 1.1% v/v	UEL: 7% v/v

Extinguishing Media: A Class 1C flammable liquid. For small fires, use dry chemical, carbon dioxide (CO_2), or regular foam. For large fires, use fog, or regular foam. Water may be ineffective since styrene tends to float on water; use only when other agents are unavailable.
Unusual Fire or Explosion Hazards: Styrene may accumulate static electricity. Hazardous polymerization can occur causing container to rupture due to heat of fire. Vapors may travel to ignition source and flash back. Styrene poses a vapor explosion hazard indoors, outdoors, and in sewers.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Use protective clothing specifically recommended by manufacturer. Apply cooling water to container sides until well after fire is out. If possible without risk, remove container from fire area. Stay away from ends of tanks. For massive fire in cargo area use monitor nozzles or unmanned hose holders; if this is impossible, withdraw from area and let fire burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Uninhibited styrene monomer is very unstable and even when inhibited (butylcatechol or hydroquinone) polymerization occurs slowly at room temperature and fast at elevated temperatures or in contact with certain initiators. **Chemical Incompatibilities:** Styrene vapor is explosive when exposed to heat or flame; reacts with oxygen above 104 °F (40 °C) to form a heat-sensitive explosive peroxide. Violent polymerization may be initiated by alkali metal-graphite composites, butyllithium, dibenzoyl peroxide, azoisobutyronitrile or di-*tert*-butyl peroxide. Styrene reacts violently with chlorosulfonic acid, oleum, sulfuric acid, chlorine + iron (II) chloride (above 50 °C) and can react vigorously with oxidizing materials. **Conditions to Avoid:** Exposure to heat and ignition sources, light, and contact with incompatibles. **Hazardous Decomposition Products:** Thermal oxidative decomposition of styrene can produce carbon dioxide, acrid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC(164) lists styrene monomer as a carcinogen; Class 2B (possibly carcinogenic, limited human evidence in the absence of sufficient animal data). **Summary of Risks:** Styrene is irritating to the eyes, skin, and respiratory system. It is absorbed through the skin at 9 to 15 mg/m²/hr (hand and forearm). Inhalation of high concentrations can cause CNS depression but styrene's pungent, irritating odor is usually enough to prevent acute toxic exposures. If heavy exposure occurs, styrene can saturate the body in 30-40 minutes, is distributed throughout the organs and is rapidly eliminated (~85% in 24 hr) either in urine (71%) or expired air (10%). Unexcreted styrene accumulates in adipose tissue (subcutaneous connective tissue containing fat cells). Ovulation and menstrual disorders were observed in women exposed to styrene. In one case, CNS effects were observed in infants whose mother was exposed to chemicals such as styrene during pregnancy. In general, pregnant women may be at elevated risk because styrene crosses the placental barrier. **Target Organs:** CNS, eyes, respiratory system, and skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Medical Conditions Aggravated by Long-term Exposure:** Possibly, liver, kidney, blood, skin, and CNS disorders.
Acute Effects: Inhalation of concentrations as low as 50 ppm causes irritation of the eyes, and respiratory tract.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Symptoms include watering eyes and nose, chest heaviness or pain, difficulty breathing, coughing, bluish face and lips, wheezing, headache, nausea, vomiting, dizziness, fatigue, diarrhea and risk of pulmonary edema (fluid in lungs). Skin contact is irritating, with itching, inflammation and possible blisters. Splashes to the eyes cause irritation, watering, lid inflammation, chemical corneal burns, and possibly, serious lesions. Cases of ingestion have not been reported but by analogy to animal studies it could cause irritation of the lips, mouth, and throat; painful swallowing, abdominal pain, nausea, vomiting, state of shock, possible convulsions and risk of pulmonary edema. **Chronic Effects:** Repeated exposure has caused "styrene sickness" described by nausea, vomiting, appetite loss, and general weakness. Occupational asthma may occur rarely. Functional disorders of the nervous system, irritation of the upper airways, and blood changes particularly leukopenia (abnormally low number of circulating, nucleated white or colorless blood cells) and lymphocytosis (increased number of lymphocytes which are involved in the immune system) have also been observed. Medical exams revealed toxic hepatitis in workers exposed to ~50 mg/m^3 styrene for over 5 yr. Prolonged exposure to < 50 mg/m^3 caused certain liver function disorders (protein, pigment, glycogen). Peripheral neuropathies were observed in chronically exposed workers. Repeated or prolonged skin exposure may cause dermatitis with rough, dry, fissured skin due to defatting.

FIRST AID Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do *not* allow victim to rub or keep eyes tightly shut. Immediately consult a physician. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not induce vomiting!* Gastric lavage may be indicated if victim is at risk of convulsing but the decision should be carefully weighed since severe esophageal irritation may occur. **Note to Physicians:** For acute exposure, give baseline liver and kidney function tests and obtain urinalysis, CBC, amylase and lipase levels. Monitor arterial blood gases and perform chest X-ray if significant respiratory irritation occurs. Phenylglyoxylic and mandelic acid may be determined in urine.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should protect against inhalation and eye and skin contact. Shut off all ignition sources. Use water spray to cool and disperse vapors (this may not prevent ignition in closed spaces). For small spill, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers. For large spills, dike far ahead of liquid spill for later disposal or reclamation. For spills in water, apply activated carbon at 10 X the spilled amount (at least 10,000 ppm) or use barriers or oil spill booms to limit motion. "Universal" gelling agent injected into spill may aid in solidification. Remove material with suction hoses or mechanical dredges. Follow applicable OSHA regulations (29 CFR 1910.120). Report spills in excess of 1000 lb. **Ecotoxicity Values:** TLm, *Pimephales promelas* (fathead minnow), 53.6 mg/L/48 hr; TLm, *Artemia salina* (brine shrimp), 68 mg/L/24 hr and 52 mg/L/48 hr. **Environmental Degradation:** In water, styrene monomer volatilizes rapidly and may be subjected to biodegradation. It is not expected to hydrolyze. In air, styrene will react rapidly with hydroxyl radicals and ozone with a combined calculated half-life of 2.5 to 9 hr. In soil, styrene will biodegrade and leach to groundwater with low to moderate mobility (depending on soil conditions). **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations Listed as a RCRA Hazardous Waste (40 CFR 261.21 & 261.23): D001 and D003, Characteristic of ignitability and reactivity
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311(b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A & Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH/MSHA-approved respirator. For < 500 ppm, use any supplied air respirator (SAR) or SCBA. For < 1250 ppm, use any SAR operated in a continuous flow mode. For < 5000 ppm, use any SAR with a full facepiece in positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol is recommended as suitable material for PPG. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Thoroughly decontaminate PPG. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Styrene is corrosive to copper or copper alloy containers. Store in cool (hazardous above 32 °C), dry, well-ventilated area away from incompatibles (Sec. 5). Store small refrigerated amounts in glass containers and large amounts in vented metal tanks in outside or detached storage under an inert blanket (i.e., nitrogen). Install electrical equipment Class 1, Group D. Inhibit styrene during storage to prevent polymerization. Uninhibited vapor may polymerize in vents and cause blockage. To prevent static sparks, electrically ground and bond all equipment used in styrene manufacture, use, storage, transfer, and shipping. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Continuously monitor workplace air levels of styrene. Make sure ducting, piping, and pipe joints are leak tight. Give preference to continuous rather than batch techniques and mechanize manual operations. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, blood, liver, kidney, and skin. Consider precluding pregnant women from styrene exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Styrene monomer, inhibited
DOT Hazard Class: Flammable liquid
ID No.: UN2055
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Styrene monomer, inhibited
IMO Hazard Class: 3.3
ID No.: UN2055
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection **References:** 73, 89, 100, 101, 103, 124, 126, 127, 131, 132, 133, 136, 139, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 318
Xylene *(Mixed Isomers)*

Issued: 11/80 Revision: E, 9/92 Errata: 12/94

Section 1. Material Identification

Xylene (Mixed Isomers) (C_8H_{10}) Description: The commercial product is a blend of the three isomers [*ortho*-(*o*-), *meta*-(*m*-), *para*-(*p*-)] with the largest proportion being *m*- xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics; as a general solvent for adhesives, a cleaning agent in microscope technique; as a solvent for Canada balsam microscopy; as a fuel component; in aviation gasoline, protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, and the leather industry; in the production of phthalic anhydride, isophthalic, and terephthalic acids and their dimethyl esters which are used in the manufacture of polyester fibers; and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.

Other Designations: CAS No. 1330-20-7 [95-47-6; 108-38-3; 106-42-3 (*o*-, *m*-, *p*-isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 2
S 2
K 3

NFPA



HMIS
H 2†
F 3
R 0
PPE ‡

† Chronic Effects
‡ Sec. 8

Cautions: Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers): the commercial product generally contains ~ 40% *m*-xylene; 20% each of *o*-xylene, *p*-xylene, and ethylbenzene; and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 150 ppm (655 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 100 ppm (435 mg/m^3)
STEL: 150 ppm (655 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 150 ppm (651 mg/m^3)
BEI (Biological Exposure Index): Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category II: Substances with systemic effects
Half-life: < 2 hr
Peak Exposure: 200 ppm, 30 min, average value, 4 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo}: 10000 ppm/6 hr; toxic effects not yet reviewed.
Human, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted.
Rat, oral, LD_{50}: 4300 mg/kg; toxic effect not yet reviewed.
Rat, inhalation, LC_{50}: 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, *RTECS* (XE2100000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range: 279 to 284 °F (137 to 140 °C)*
Boiling Point: *ortho:* 291 °F (144 °C); *meta:* 281.8 °F (138.8 °C); *para:* 281.3 °F (138.5 °C)
Freezing Point/Melting Point: *ortho:* -13 °F (-25 °C); *meta:* -53.3 °F (- 47.4 °C); *para:* 55 to 57 °F (13 to 14 °C)
Vapor Pressure: 6.72 mm Hg at 70 °F (21 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3): 1.23 kg/m^3, 0.077 lbs/ft^3

Appearance and Odor: Clear, sweet-smelling liquid.

Molecular Weight: 106.16
Specific Gravity: 0.864 at 20 °C/4 °C
Water Solubility: Practically insoluble
Other Solubilities: Miscible with absolute alcohol, ether, and many other organic liquids.
Octanol/Water Partition Coefficient: logKow = 3.12-3.20
Odor Threshold: 1 ppm
Viscosity: <32.6 SUS

* Materials with wider and narrower boiling ranges are commercially available.

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 °F (17 to 25 °C) CC | **Autoignition Temperature:** 982 °F (527 °C) (*m*-) | **LEL:** 1.1 (*m*-, *p*-); 0.9 (*o*-) | **UEL:** 7.0 (*m*-, *p*-); 6.7 (*o*-)

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards:** Xylene vapors or liquid (which floats on water) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid flow sufficient to cause ignition. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Xylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. **Chemical Incompatibilities:** Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidindione (dichlorohydrantoin). Xylene attacks some forms of plastics, rubber, and coatings. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list xylene as a carcinogen. **Summary of Risks:** Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm; severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. Kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated mild reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Menstrual irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. **Medical Conditions Aggravated by Long-Term Exposure:** CNS, respiratory, eye, skin, gastrointestinal (GI) , liver and kidney disorders. **Target Organs:** CNS, eyes, GI tract, liver, kidneys, and skin. **Primary Entry Routes:** Inhalation, skin absorption (slight), eye contact, ingestion. **Acute Effects:** Inhalation of high xylene concentrations may cause dizziness; nausea, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid in lung); drowsiness; and unconsciousness. Direct eye contact can result in conjunctivitis and corneal burns. Ingestion may cause a burning sensation in the oropharynx and stomach and transient CNS depression. **Chronic Effects:** Repeated or prolonged skin contact may cause drying and defatting of the skin leading to dermatitis. Repeated eye exposure to high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis, and GI disturbances such as nausea, loss of appetite, and gas.

FIRST AID *Emergency personnel should protect against exposure.* **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing as it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Monitor exposed person for respiratory distress. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, *do not induce vomiting!* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs). *Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage.* **Note to Physicians:** Hippuric acid or the ether glucuronide of *ortho*-toluic acid may be useful in diagnosis of *meta-*, *para-* and *ortho*-xylene exposure, respectively. Consider gastric lavage if a large quantity of xylene was ingested. Proceed gastric lavage with protection of the airway from aspiration; consider endotracheal intubation with inflated cuff.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors. Water spray may reduce vapor, but does not prevent ignition in closed spaces. For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal. For large spills dike far ahead of liquid to contain. Do not allow xylene to enter a confined space such as sewers or drains. On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal gelling agent; and use suction hoses to remove spilled material. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** Little bioconcentration is expected. Biological oxygen demand 5 (after 5 days at 20 °C): 0.64 (no stated isomer). **Ecotoxicity values:** LD_{50}, Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. **Environmental Degradation:** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr. in the summer to 10-18 hr in winter or a typical loss of 67-86% per day. Xylenes are resistant to hydrolysis. **Soil Absorption/Mobility:** Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into groundwater. **Disposal:** As a hydrocarbon, xylene is a good candidate for controlled incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U239, F003 (spent solvent)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4); per RCRA, Sec. 3001]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges; any powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator; or any self-contained breathing apparatus. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.*Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times > 8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. During transferring operations, electrically ground and bond metal containers. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating surfaces, and provide sources of gas release with enclosures and local exhaust ventilation. Use Class I, Group D electrical equipment. **Administrative Controls:** Establish air and biological monitoring programs and evaluate regularly. Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests. Consider hematologic studies if there is any significant contamination of the solvent with benzene. If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Xylenes
DOT Hazard Class: 3
ID No.: UN1307
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Nonbulk Packaging : 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: –

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 176, 180.
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 683
Polychlorinated Biphenyls (PCBs)

Issued: 11/88 Revision: A, 9/92

Section 1. Material Identification

Polychlorinated Biphenyls [$C_{12}H_{10-n}Cl_n$ (n=3, 4, 5)] Description: A class of nonpolar chlorinated hydrocarbons with a biphenyl nucleus (two benzene nuclei connected by a single C-C bond) in which any or all of the hydrogen atoms have been replaced by chlorine. Commercial PCBs are mixtures of chlorinated biphenyl isomers with varying degrees of chlorination. Prepared industrially by the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst such as ferric chloride or iron filings. Except for limited research and development applications, PCBs have not been produced in the US since 1977. When large quantities of PCBs were manufactured in the US, they were marketed under the tradename Aroclor (Monsanto) and were characterized by four digit numbers. The first two digits indicating biphenyls (12), triphenyls (54), or both (25, 44); the last two digits indicating the weight percent of chlorine. PCBs' thermal stability, nonflammability, and high dielectric capability made them very useful in electrical equipment. Formerly used as additives in hydraulic fluids, heat transfer systems, lubricants, cutting oils, printer's ink, fire retardants, asphalt, brake linings, automobile body sealants, plasticizers, adhesives, synthetic rubber, floor tile, wax extenders, dedusting agents, pesticide extenders, and carbonless reproducing paper. PCBs are still used in certain existing electrical capacitors and transformers that require enhanced electrical protection to avoid heating from sustained electric faults.

R 1
I 4
S 3*
K 1
* Skin absorption

NFPA



HMIS
H 2‡
F 1
R 0
PPE†
† Sec. 8
‡ Chronic Effects

Other Designations: CAS No. 1336-36-3, Aroclor, Clophen, Chlorextol, chlorinated biphenyls, chlorinated diphenyl, chlorinated diphenylene, chloro biphenyl, chloro-1,1-biphenyl, Dykanol, Fenclor, Inerteen, Kaneclor, Montar, Noflamol, Phenoclor, Pyralene, Pyranol, Santotherm, Sovol, Therminol FR-1

Cautions: PCBs are potent liver toxins that may be absorbed through skin. Potentially, chronic or delayed toxicity is significant because PCBs accumulate in fatty tissue and may reasonably be anticipated to be carcinogens. PCBs are a bioaccumulative environmental hazard. When burned, decomposition products may be more hazardous than the PCBs.

Section 2. Ingredients and Occupational Exposure Limits

PCBs, contain various levels of polychlorinated dibenzofurans and chlorinated naphthalenes as contaminants

1991 OSHA PELs, Skin
8-hr TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
8-hr TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

1990 DFG (Germany) MAK, Danger of Cutaneous Absorption
TWA (Chlorodiphenyl, 42% chlorine): 0.1 ppm (1 mg/m^3)
Category III: Substances with systemic effects, onset of effect > 2 hr., half-life > shift length (strongly cumulative)
Short-term Level: 1 ppm, 30 min., average value, 1 per shift

TWA (Chlorodiphenyl, 54% chlorine): 0.05 ppm (0.5 mg/m^3)
Category III: (see above)
Short-term Level: 0.5 ppm, 30 min., average value, 1 per shift

1985-86 Toxicity Data*
Rat, oral, TD: 1250 mg/kg administered intermittently for 25 weeks produced liver tumors.
Mammal, oral, TD_{Lo}: 325 mg/kg administered to female for 30 days prior to mating and from the 1st to the 36th day of gestation produced effects on newborn (stillbirth; live birth index; viability index).

1990 NIOSH REL
TWA (Chlorodiphenyl, 42% chlorine): 0.001 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.001 mg/m^3

1992-93 ACGIH TLVs, Skin *
TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

* These guidelines offer reasonably good protection against systemic intoxication, but may not guarantee that chloroacne won't occur.
† See NIOSH, *RTECS* (TQ1350000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: 644-707 °F (340-375 °C)
Melting Point: 42%: -2.2 °F (-19°C); 54%: 14 °F (-10 °C)
Vapor Pressure: 1 mm Hg at 100 °F (38 °C); 10^{-6} to 10^{-3} mm at 20 °C
Molecular Weight: 188.7 to 398.5

Specific Gravity: 1.3 to 1.8 at 20 °C
Water Solubility: Low solubility (0.007 to 5.9 mg/L)
Other Solubilities: Most common organic solvents, oils, and fats; slightly soluble in glycerol and glycols.

Appearance and Odor: PCBs vary from mobile oily liquids to white crystalline solids and hard non-crystalline resins, depending upon chlorine content.

* Physical and chemical properties vary widely according to degree and to the position of chlorination.

Section 4. Fire and Explosion Data

Flash Point: 286-385 °F (141-196 °C) OC*	Autoignition Temperature: 464 °F (240 °C)	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing media suitable to the surrounding fire. Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water spray may be ineffective. Use water spray to cool fire-exposed containers or transformers. Do not scatter PCBs with high-pressure water streams. **Unusual Fire or Explosion Hazards:** Combustion products (hydrogen chloride, phosgene, polychlorinated dibenzofurans, and furans) are more hazardous than the PCBs themselves. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Approach fire from upwind to avoid highly toxic decomposition products. Structural firefighter's protective clothing will provide *limited* protection. Do not release runoff from fire control methods to sewers or waterways. Dike for later disposal.

* Flash points shown are a range for various PCBs. Some forms do not have flash points.

Section 5. Reactivity Data

Stability/Polymerization: PCBs are very stable materials but are subject to photodechlorination when exposed to sunlight or UV (spectral region above 290 nanometers). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** PCBs are chemically inert and resistant to oxidation, acids, and bases. **Conditions to Avoid:** Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition [1112-1202 °F (600-650 °C)] of PCBs can produce highly toxic derivatives, including polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), hydrogen chloride, phosgene and other irritants.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] and NTP[169] list PCBs as an IARC probable carcinogen (overall evaluation is 2A; limited human data; sufficient animal data) and NTP anticipated carcinogen, respectively. **Summary of Risks:** PCBs are potent liver toxins that can be absorbed through unbroken skin in toxic amounts without immediate pain or irritation. PCBs have low acute toxicity, but can accumulate in fatty tissue and severe health effects may develop later. Generally, toxicity increases with a higher chlorine content; PCB-oxides are more toxic. The toxic action on the liver also increases with simultaneous exposure to other liver toxins, e.g. chlorinated solvents, alcohol, and certain drugs. Pathological pregnancies (abnormal pigmentations, abortions, stillbirths, and underweight births) have been associated with increased PCB serum levels in mothers; PCBs can be passed in breast milk. PCBs can affect the reproductive system of adults. **Medical Conditions Aggravated by Long-Term Exposure:** Skin, liver, and respiratory disease. **Target Organs:** Skin, liver, eyes, mucous membranes, and respiratory tract. **Primary Entry Routes:** Inhalation, dermal contact, ingestion. **Acute Effects:** Exposure to PCB vapor or mist is severely irritating to the skin, eyes, nose, throat, and upper respiratory tract. Intense acute exposure to high concentrations may result in eye, lung, and liver injury. Systemic effects include nausea, vomiting, increased blood pressure, fatigue, weight loss, jaundice, edema and abdominal pain. Cognitive, neurobehavior and psychomotor impairment and memory loss have also been seen after acute exposure. **Chronic Effects:** Repeated exposure to PCBs can cause chloroacne; redness, swelling, dryness, thickening and darkening of the skin and nails; swelling and burning of the eyes, and excessive eye discharge; distinctive hair follicles; gastrointestinal disturbances; neurological symptoms including headache, dizziness, depression, nervousness, numbness of the extremities, and joint and muscle pain; liver enlargement; menstrual changes in women; and chronic bronchitis. Cancer, primarily liver, is also a possible result of exposure, but data is inconclusive.

FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Rinsing eyes with medical oil (olive, mineral) initially may remove PCB and halt irritation better than water rinsing alone. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. *Multiple soap and water washings are necessary.* Avoid the use of organic solvents to clean the skin. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** In most cases, accidental PCB ingestion will not be recognized until long after vomiting would be of any value. Never give anything by mouth to an unconscious or convulsing person. Vomiting of the pure substance may cause aspiration. Consult a physician. **Note to Physicians:** Monitor patients for increased hepatic enzymes, chloroacne, and eye, gastrointestinal, and neurologic symptoms listed above. Diagnostic tests include blood levels of PCBs and altered liver enzymes.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and isolate hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. For small spills, take up with sand or other noncombustible material and place into containers for later disposal. For larger spills, dike far ahead of spill to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** PCBs have been shown to bio-concentrate significantly in aquatic organisms. **Ecotoxicity:** Bluegill, TLm: 0.278 ppm/96 hr. Mallard Duck, LD_{50}: 2000 ppm. **Environmental Degradation:** In general, the persistence of PCBs increases with an increase degree of chlorination. **Soil Absorption/Mobility:** PCBs are tightly absorbed in soil and generally do not leach significantly in most aqueous soil systems. However, in the presence of organic solvents, PCBs may leach rapidly through the soil. Volatilization of PCBs from soil may be slow, but over time may be significant. **Disposal:** Approved PCB disposal methods include: incineration with scrubbing, high-efficiency boilers, landfills, and EPA-approved alternative disposal methods. Each disposal method has various criteria. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 311(b)(4) and 307(a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Minimum respiratory protection should include a combination dust-fume-mist and organic vapor cartridge or canister or air-supplied, depending upon the situation. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Butyl rubber, neoprene, Teflon, and fluorocarbon rubber have break through times greater than 8 hrs. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Segregate contaminated clothing in such a manner so that there is no direct contact by laundry personnel. Implement quality assurance to ascertain the completeness of the cleaning procedures. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a closed, labelled, container in a ventilated area with appropriate air pollution control equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Inform employees of the adverse health effects associated with PCBs. Limit access to PCB work areas to authorized personnel. Consider preplacement and periodic medical examinations with emphasis on the skin, liver, lung, and reproductive system. Monitor PCB blood levels. Consider possible effects on the fetus. Keep medical records for the entire length of employment and for the following 30 yrs.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Polychlorinated biphenyls
DOT Hazard Class: 9
ID No.: UN2315
DOT Packing Group: II
DOT Label: CLASS 9
Special Provisions (172.102): 9, N81

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 100 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 34

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 163, 164, 168, 169, 174, 175, 180
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy MPH, CIH; **Medical Review:** AC Darlington, MD

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Material Safety Data Sheet Collection

2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin (TCDD)

MSDS No. 906 Date of Preparation: 6/94

Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: 2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin (TCDD)
Chemical Formula: $C_{12}H_4Cl_4O_2$
CAS No.: 1746-01-6
Synonyms: dioxin; dioxine; NCI-C03714; tetrachlorodibenzodioxin; 2, 3, 7, 8-tetrachlorodibenzo(b, e)(1, 4)dioxin; 2, 3, 7, 8-tetrachlorodibenzo-1, 4-dioxin; TCDBD; TCDD; 2, 3, 7, 8-TCDD; tetradioxin
Derivation: TCDD is not manufactured, but is formed as a by-product of chlorobenzenes, chlorophenols, and the herbicides 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) and 2-(2, 4, 5-trichlorophenoxy)propionic acid (Silvex) which are produced from 2, 4, 5-trichlorophenol (TCP). 2, 4, 5-T, commonly known as Agent Orange, was the defoliant used during the Vietnam War. TCP, 2, 4, 5-T and Silvex are no longer commercially produced in the U.S. As a chemical and toxicological standard, TCDD can be prepared by catalytic condensation of potassium 2, 4, 5-trichlorophenate. TCDD has been released to the environment during the incineration of chemical wastes including chlorinated benzenes, chlorophenols, and biphenyl ethers, from the improper disposal of certain chlorinated chemical wastes, in emissions from wood burning in the presence of chlorine, in accidental fires involving transformers containing PCBs, and from the use of the herbicides 2, 4, 5-T and Silvex.
General Use: TCDD is an extremely toxic, unwanted by-product and essentially has no beneficial uses. It may be used as a research chemical. **Vendors:** Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

2, 3, 7, 8-Tetrachlorodibenzo-*p*-dioxin, ca 100 %wt. TCDD normally persists as a contaminant in TCP in variable amounts (0.07-6.2 mg/kg). Consequently, the concentrations of TCDD in different batches of Agent Orange varied greatly with an average concentration of about 2 ppm.

OSHA PEL*
None established

NIOSH REL
Carcinogen, lowest feasible concentration.

DFG (Germany) MAK
None established

ACGIH TLV
None established

* A preliminary occupational exposure limit of 0.2 ng/m^3 (200 pg/m^3) is recommended. It provides an ample margin of safety to prevent chloracne and takes into consideration the chronic effects of animal studies and accidental human exposure. [Leung HW et al; *American Industrial Hygiene Association Journal*, 49 (9): 466-74 b(1988)]

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

TCDD is a colorless, crystalline solid at room temperature. It is highly toxic and a potential human carcinogen. Exposure to TCDD-contaminated materials may cause a severe and disabling acne-like rash that may persist for years (chloracne), metabolic disorders, and nervous system and liver damage. In animals, TCDD causes teratogenesis, tumorigenesis, and immunological dysfunction. Findings in humans are inconclusive, but human toxicology is under continuing investigation. Workers may be exposed to TCDD from residues from prior production or use of 2, 4, 5-T or Silvex, waste materials contaminated by TCDD, or contamination resulting from transformer fires. Take every precaution to avoid any exposure to TCDD.

Wilson Risk Scale	
R	1
I	4
S	4*
K	1

*Skin absorption

HMIS	
H	4†
F	1
R	0

†Chronic Effects
PPE‡
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation (dust),* skin contact, ingestion.
Target Organs: Skin, liver, and nervous system.
Acute Effects
Inhalation: Shortness of breath, headaches, fatigue, severe muscle pains, weakness, and digestive disturbance. Most symptoms develop slowly, over many days.
Eye: Conjunctivitis and chemical burns.
Skin: Chemical burns. In most cases, chloracne appears within 2 to 4 weeks after initial exposure. It consists of blackheads with small, pale-yellow cysts. In severe cases, there may be papules (red spots) or even pustules (pus-filled spots). This acne-like rash appears on the cheekbones under the eyes and behind the ears in very mild cases. With increasing severity, the rest of the face and neck are affected and the outer upper arms, chest, back, abdomen, outer thighs and genitalia may be involved in varying degrees in the worst cases. In the worst cases, lesions may be active 15 or more years after the contact has ceased. Chloracne may also appear after ingestion or inhalation. Skin fragility, hirsutism (excessive growth of hair of normal or abnormal distribution), and photosensitivity may also occur.
Ingestion: Nausea, vomiting, and possible pancreatitis.

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Carcinogenicity: The IARC, NTP, MAK , and NIOSH list TCDD as an IARC-2B (possibly carcinogenic to humans: inadequate evidence of carcinogenicity in humans but there is sufficient evidence of carcinogenicity in experimental animals), an NTP-2 (reasonably anticipated to be a carcinogen: limited evidence from studies in humans or sufficient evidence from studies in experimental animals), an MAK-A2 (unmistakably carcinogenic in animal experimentation only), and a NIOSH-X (carcinogen defined with no further categorization). OSHA does not list TCDD as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Skin, liver, nervous and endocrine system disorders.
Chronic Effects: Lack of energy, loss of sex drive, personality and mood changes, numbness, weakness and pain in the legs, liver damage, chloracne, and elevated blood lipids. TCDD increased the incidence of a variety of tumors in animals, but human data is inconclusive. Little is known of the human health effects (if any) as a result of long-term exposures to low concentrations.
Comments: The observed health effects from clinical or epidemiological studies of populations who were occupationally and non-occupationally exposed cannot be solely attributed to TCDD because of the concurrent exposure to 2, 4, 5-T and TCP and to other herbicides as well. There is no report of human exposure to TCDD alone.
* Vapor inhalation is unlikely because TCDD has a low vapor pressure.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin Contact: *Quickly* remove contaminated clothing. Flush with water to remove solid particles; follow with a soap and water wash of exposed areas. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: For an acute exposure, obtain liver function tests, CBC, prothrombin time, serum lipids, and uroporphyrins. EMG may be useful in detecting subclinical neuropathy. Current analytical techniques to detect dioxins in human tissue specimens involve gas chromatography and mass spectrometry. Chloracne may respond to topical retinoic acid, and oral tetracyclines may help secondary pustular follicles. Resistant cases may require dermabrasion or acne surgery. Isotretinoin may be tried.
Special Precautions/Procedures: Emergency personnel should protect against contamination.

Section 5 - Fire-Fighting Measures

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Flash Point: None reported.
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam extinguisher.
Unusual Fire or Explosion Hazards: None reported.
Hazardous Combustion Products: Toxic fumes of chlorine.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of spill, evacuate all unnecessary personnel, remove heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against skin and eye contact and dust inhalation.
Small Spills: Carefully collect and place in sealed containers for disposal.
Large Spills
Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.
Cleanup: Avoid generating dust. *Do not* sweep! Provide an organized procedure of containment, collection, and disposal of contaminated solutions and residues generated during cleanup. Provide separate facilities for decontamination of large equipment. Conduct repetitive wash/rinse cycles separately, either by using different locations or by spacing in time.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120). For specific recommendations, contact your Department of Environmental Protection or your regional EPA office.

Section 7 - Handling and Storage

Handling Precautions: Handle with extreme caution. Take all the necessary precautions to avoid any exposure.
Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Isolate work areas involving TCDD or TCDD-contaminated materials.

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Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103) **Administrative Controls:** Consider preplacement and periodic medical examinations with emphasis on the skin, liver, nervous and endocrine systems. Regularly monitor glassware, bench tops, instruments, and tools with wipe tests (wipe with filter paper and measure amount of TCDD). **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For situations where TCDD contamination is low (e.g., exposure to dust contaminated with low levels of TCDD), wear an air-purifying respirator until the extent and characterization of the exposure can be determined. For materials highly contaminated with TCDD, wear respirators that consist of self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive pressure mode. An alternate method utilizes a combination Type C supplied-air respirator, with full facepiece, operated in a pressure-demand mode and equipped with auxiliary positive pressure self-contained air supply. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Protective Clothing/Equipment:** Consider disposable clothing due to the uncertainty of adequate decontamination. Wear protective clothing consisting of both outer (zippered coverall with attached hood and draw string or elastic sleeves, gloves and closure boots) and inner (cotton overalls, undershirts, undershorts, gloves, and socks) garments. For dust or particulate exposure, wear coveralls of a non-woven fabric such as Tyvek or spun bonded polyethylene. For exposure to liquids, wear coveralls, gloves, and boots made of chemically resistant materials such as Saranax coated Tyvek or butyl, nitrile, or neoprene rubber. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area. **Contaminated Equipment:** Shower and change clothes after potential exposures or at the end of the work day. Separate contaminated work clothes from street clothes. Launder before reuse. Place disposable clothing in marked and approved containers for disposal. Remove this material from your shoes and clean personal protective equipment. To prevent cross-contact, provide segregated decontamination locations with separate, controlled, and well-marked entry/exit routes and locations. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Colorless needles
Water Solubility: 19.3 ng/L
Other Solubilities: *o*-dichlorobenzene (1.4 g/L); chlorobenzene (0.72 g/L); benzene (0.57 g/L); chloroform (0.37 g/L); acetone (0.11 g/L); *n*-octanol (0.05 g/L); methanol (0.01 g/L); lard oil (0.04 g/L)

Vapor Pressure: 7.4×10^{-10} mm Hg at 77 °F (25 °C)
Formula Weight: 322
Melting Point: 581-583 °F (305-306 °C)
Octanol/Water Partition Coefficient: log Kow= 7.02
Henry's Law Constant: 1.62×10^{-5} atm m^3/mole at 25 °C (estimated)

Section 10 - Stability and Reactivity

Stability: TCDD is relatively stable toward heat, acids, and alkalis. It is changed chemically when exposed in isooctane or *n*-octanol to UV light. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** None reported. **Conditions to Avoid:** Avoid heat and ignition sources. **Hazardous Decomposition Products:** Thermal oxidative decomposition of TCDD can produce toxic fumes of chlorine. Decomposition begins at 932 °F (500 °C) and complete decomposition occurs within 21 sec at 1472 °F (800 °C).

Section 11- Toxicological Information

Toxicity Data:*

Eye Effects:
Rabbit, eye: 2 mg caused moderate irritation.
Acute Effects:
Human, skin, TD_{Lo}: 107 µg/kg produced dermatitis and allergic reaction.
Mammal, oral, LD_{50}: 4200 ng/kg produced changes of the liver, kidney, ureter, bladder, and spleen.
Rat, oral, LD_{50}: 20 µg/kg
Reproductive Effects:
Monkey, oral, TD_{Lo}: 92 ng/kg (46 weeks prior to mating, on each day during gestation, and for 17 weeks following birth) caused effects on the newborn (behavioral; delayed effects).
Genetic Effects:
Human cell: 100 pmol/L caused unscheduled DNA synthesis.

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Genetic Effects *(continued)*:
Human cell: 10 nmol/L caused DNA inhibition.
Tumorigenic Effects:
Rat, oral: 52 µg/kg/2 yr (intermittent) caused liver and thyroid tumors.
Rat, oral: 27 µg/kg/65 weeks (continuous) caused liver and kidney tumors.
Multiple Dose:
Rat, oral: 6500 ng/kg/13 weeks (intermittent) caused changes in liver and thymus weight and pigmented or nucleated red blood cells.
Mouse, skin: 97 µg/kg/13 weeks (intermittent) caused diffuse hepatitis (hepatocellular necrosis); changes in spleen; and death.
* See NIOSH, *RTECS* (HP3500000), for additional toxicity data.

Section 12 - Ecological Information

Environmental Transport: Bioconcentration will occur in aquatic organisms. Due to TCDD's low solubility in water and lipids as well as its low partition coefficient in lipids, TCDD is not likely to accumulate in as many biological systems as DDT.
Environmental Degradation: When released to the atmosphere, gas-phase TCDD is degraded by reaction with hydroxyl radicals and direct photolysis (half-life =8.3 days). Particulate-phase TCDD may be physically removed from air by wet and dry deposition. TCDD may be transported long distances through the atmosphere with surface water sediments being an ultimate environmental sink of airborne particulates. TCDD will absorb to sediment and limit the overall rate by which TCDD is removed from water. TCDD near the water's surface may experience significant photodegradation. 1.5 yr is the persistence half-life of TCDD in lakes. TCDD is generally resistant to biodegradation. Photodegradation on terrestrial surfaces may be an important transformation process. During warm conditions, volatilization from soil surfaces may be a major removal mechanism. Volatilization of TCDD from dry soil surfaces is likely to be faster than from wet soil surfaces. TCDD that has been mixed into soil depths beneath the upper surface boundary will volatilize extremely slowly. On soil surfaces, persistence half-life of TCDD on soil surfaces varies from less than 1 yr to 3 yr. Half-lives in soil interiors may be as long as 12 yr.
Soil Absorption/Mobility: TCDD is immobile in soil and is not expected to leach. Lateral movement due to surface erosion may occur.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Environmentally hazardous substances, solid, n.o.s.*
Shipping Symbols: —
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9
Special Provisions (172.102): 8, B54, N50

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: None
b) Cargo Aircraft Only: None

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: —

* If it is in a quantity, in one package which equals or exceeds the RQ of 1 lb (0.454 kg).

Section 15 - Regulatory Information

EPA Regulations: RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations: Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 139, 184, 187, 189, 190, 193
Prepared By MJ Wurth, BS **Industrial Hygiene Review** PA Roy, MPH, CIH **Medical Review** T Thoburn, MD, MPH
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Material Safety Data Sheets Collection:
Sheet No. 317
Toluene
Issued: 8/79 Revision: E, 9/92 Errata: 2/94

Section 1. Material Identification

Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.
Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 3
S 2*
K 3
* Skin absorption

NFPA

HMIS
H 2 Chronic effects
F 3
R 0
PPE-Sec. 8

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

Section 2. Ingredients and Occupational Exposure Limits

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m³)
15-min STEL: 150 ppm (560 mg/m³)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m³)
STEL: 150 ppm (560 mg/m³)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m³)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m³)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinations, and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 °F (110.6 °C)
Melting Point: -139 °F (-95 °C)
Molecular Weight: 92.15
Density: 0.866 at 68 °F (20/4 °C)
Surface Tension: 29 dyne/cm at 68 °F (20 °C)
Viscosity: 0.59 cP at 68 °F (20 °C)
Refraction Index: 1.4967 at 20 °C/D

Water Solubility: Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 °F (20 °C); 36.7 mm Hg at 86 °F (30 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.0797 lb/ft³ or 1.2755 kg/m³
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 °F (4.4 °C) CC	Autoignition Temperature: 896 °F (480 °C)	LEL: 1.27% v/v	UEL: 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/min and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact with heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list toluene as a carcinogen. **Summary of Risks:** Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm²/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to its lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia with biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palpebral fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluene causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next page

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Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, kidney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and symptoms associated with inhalation. **Chronic Effects:** Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and alcohol intolerance. Repeated heavy exposure may result in encephalopathies (cerebellar ataxia and cognitive dysfunction), liver enlargement, and kidney dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend. **FIRST AID Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. **Note to Physicians:** Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/g creatinine); Toluene in venous blood, sample at shift end (1.0 mg/L).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dike far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 °F (450 to 980 °C), rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C), or liquid injection incineration at 1202 to 2912 °F (650 to 1600 °C). Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Blue gill, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 36.2 mg/L/96 hr. **Environmental Degradation:** If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photochemically produced hydroxyl radicals. **Disposal:** Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
[* per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307 (a)]
Listed as a SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 2000 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facepiece, or any air-purifying respirator with a full facepiece having a chin-style, front or back mounted organic vapor canister. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove toluene from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquids warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, wells, storage tanks). Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Toluene
DOT Hazard Class: 3
ID No.: UN1294
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 150
b) Non-bulk Packaging: 202
c) Bulk Packaging: 242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
Vessel Stowage: B
Other: --

***SDS Collection* References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, CIH, MPH; **Medical Review:** AC Darlington, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 7
Nitric Acid

Issued: 10/88 Revision: D, 9/92

Section 1. Material Identification

Nitric Acid (HNO_3) Description: A solution of nitrogen dioxide in water commercially available in many concentrations. Derived by oxidation of ammonia by catalytic process (heated platinum catalyst); or by direct synthesis, combining atmospheric nitrogen and oxygen in an electric arc (an expensive process, thus largely abandoned). HNO_3 is usually found in conjunction with nitrogen dioxide, which is considered more hazardous. Used in fertilizer production (ammonium nitrate), in photoengraving, steel etching, explosives (TNT, nitroglycerin, trinitrophenol); manufacture of metallic nitrates, sulfuric acid, aqua regia and oxalic acid, jewelry, various dyes and dyestuffs, pharmaceuticals; as a laboratory reagant, in metallurgy (*mainly* as a pickling agent) and the printing industy.
Other Designations: CAS No. 7697-37-2, aqua fortis, aqua regia, azotic acid, engravers nitrate, hydrogen nitrate, red fuming nitric acid (RFNA), white fuming nitric acid (WFNA).
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for suppliers list.

Cautions: Nitric acid is a corrosive, strong oxidizer that causes irritation or severe burns to the skin, eyes, and respiratory tract. Exposures to high levels of the concentrated acid can be fatal. Increases the flammability of combustibles. Use extreme caution when handling HNO_3.

	HMIS		NFPA
R 2	H 3*	*Fuming* nitric acid	
I 4	F 0		
S 4	R 1		
K 0	PPE**		
R 2	H 3*	*> 40%* nitric acid	
I 4	F 0		
S 4	R 1		
K 0	PPE**		
R 2	H 3*	*≤ 40%* nitric acid	
I 3	F 0		
S 3	R 0		
K 0	PPE**		

* Chronic effects ** See Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Nitric acid, various %. Commercially available in nearly all concentrations; most common are 56 and 68%. RFNA (85%), WFNA (97.5%).

1991 OSHA PELs
8-hr TWA: 2 ppm (5 mg/m³)
15-min STEL: 4 ppm (10 mg/m³)

1990 IDLH Level
100 ppm

1990 NIOSH REL
8-hr TWA: 2 ppm (5 mg/m³)
15-min STEL: 4 ppm (10 mg/m³)

1992-93 ACGIH TLVs
TWA: 2 ppm (5.2 mg/m³)
STEL: 4 ppm (10 mg/m³)

1990 DFG (Germany) MAK
2 ppm (5 mg/m³)
Category I: local irritants
Peak Exposure Limit: 2 ppm
5 min momentary value, 8 per shift

1985-86 Toxicity Data*
Man, unreported route, LD_{Lo}: 110 mg/kg; toxic effects not yet reviewed
Rat, oral, TD_{Lo}: 5275 g/kg administered from 1 to 21 days of pregnancy caused post-implantation mortality and specific developmental abnormalities of the musculoskeletal system.
Rat, inhalation, LC_{50}: 67 ppm (NO_2)/4 hr; toxic effects not yet reviewed

* See NIOSH, *RTECS* [QU5775000 (nitric acid), QU5900000 (RFNA), QU6000000 (WFNA)] , for additional reproductive and toxicity data.

Section 3. Physical Data

Boiling Point: 186.8 °F (86 °C)
Melting Point: -43.6 °F (-42 °C)
Vapor Pressure: 67% HNO_3 = 6.8 mm Hg at 68 °F (20 °C); 95 to 98% = 113 at 100.4 °F (38 °C)
Saturated Vapor Density (Air = 1.2 kg/m³): 1.212 kg/m³ or 0.0757 lb/ft³ (67 % HNO_3)
pH: 1

Molecular Weight: 63.02
Density: 1.50269 at 77/39.2 °F (25/4 °C)
Water Solubility: Soluble (releases heat)
Ionization Potential: 11.95 eV

Appearance and Odor: Transparent, clear to yellow, fuming liquid with an acrid, suffocating odor which darkens to a brownish color on aging and exposure to light. "Fuming" nitric acid is red-brown in color.

Section 4. Fire and Explosion Data

Flash Point: Noncombustible	Autoignition Temperature: Noncombustible	LEL: None reported	UEL: None reported

Extinguishing Media: For small fires (< 40% HNO_3), use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam. For small fires (> 40% HNO_3), use water spray, dry chemical, or soda ash. For large fires, flood area with water (*do not* get inside HNO_3 containers). Apply water from as far a distance as possible.
Unusual Fire or Explosion Hazards: HNO_3 is noncombustible but is an oxidizer which increases fire involving combustibles and can initiate an explosion. It releases flammable hydrogen gas in contact with many metals.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is not effective for fires involving nitric acid. Acid-resistant clothing is needed. Apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Nitric acid decomposes in air and in contact with light and organic matter. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Nitric acid reacts explosively with combustibles, organics or readily oxidizable materials such as wood, turpentine, metal powder and hydrogen sulfide, carbides, cyanides, and alkalies; causes spattering with strong bases; is corrosive to paper, cloth and most metals (except aluminum, gold, platinum, thorium, and tantalum. Will also attack some forms of plastics, rubber, and coatings. There are at least 150 chemicals and chemical combinations which are incompatible with nitric acid. HNO_3 reacts with water to produce heat and toxic corrosive fumes. Refer to *Genium* references 126 and 159 for further detail. **Conditions to Avoid:** Avoid exposure to moisture, heat, and incompatibles.
Hazardous Decomposition Products: Thermal oxidative decomposition of HNO_3 produces nitrogen peroxide and toxic, irritating nitrogen oxides.

Section 6. Health Hazards Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list nitric acid as a carcinogen.
Summary of Risks: Nitric acid is very corrosive to the skin, eyes, digestive and respiratory tract or any tissue it comes in contact with. 58 to 68% (nitric acid) vapors are moderately irritating and can't be tolerated at high concentrations. 95% (nitric acid) vapors cause severe irritation at very low levels and the liquid causes 2nd and 3rd degree burns on short contact with skin or eyes. Vapor inhalation may cause pulmonary edema (fluid in lungs) leading to death. HNO_3 vapor or mist can slowly corrode teeth when chronically exposed. **Medical Conditions Aggravated by Long-Term Exposure:** Chronic respiratory diseases. **Target Organs:** Eyes, skin, respiratory tract, teeth.

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Section 6. Health Hazard Data, continued

Primary Entry Routes: Inhalation, ingestion, skin and eye contact. **Acute Effects:** Inhalation symptoms may take several hours and include throat and nose irritation, cough, chest pain, difficulty breathing, salivation, giddiness, nausea, muscular weakness, ulceration of nasal mucous membranes, pulmonary edema, and chemical pneumonia. Skin contact is moderately irritating to severely corrosive depending on % of nitric acid. Burns may penetrate deeply causing ulcers. Skin may be stained yellowish brown. Dilute solutions cause irritation and tend to harden the epithelium (outer skin layer) without destroying it. HNO_3 liquid causes yellow discoloration of the eyes and severe burns which may result in permanent damage, i.e., sight loss. Ingestion produces immediate pain and digestive tract burns followed by throat swelling, convulsions, risk of stomach perforation (causing a rigid abdomen) and possible coma. **Chronic Effects:** Repeated inhalation of low concentrations may cause chronic bronchitis, tooth erosion, and/or appetite loss. Repeated exposure to $NO_{(x)}$ such as produced by thermal decomposition of HNO_3 is implicated in chronic lung diseases.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing (*do not force removal if stuck to skin*). Rinse with flooding amounts of water for at least 15 min. Apply a 5% triethanolamine solution to affected area. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute followed by lime milk or milk of magnesia. Do not induce vomiting. *Do not* give sodium bicarbonate or attempt to neutralize the acid.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Observe for several hours since symptoms such as pulmonary edema may be delayed.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should wear fully-encapsulating vapor-protective clothing. Use water spray to cool and disperse vapor. Keep combustibles away from spilled material. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in dry containers for disposal. For large spill, flush with water to containment area and neutralize with agricultural (slaked) lime, sodium bicarbonate, crushed limestone, soda ash, or lime. Report any release in excess of 1000 lb. Control runoff and dike for disposal. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 1000 lb

Listed as a RCRA Hazardous Waste (40 CFR 261.22): No. D001, Characteristic of corrosivity

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311(b)(4)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Listed as a Process Safety Hazardous Chemical (29 CFR 1910.119), TQ: 500 lb

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For < 50 ppm, use any supplied-air respirator operated in a continuous-flow mode. For < 100 ppm, use any supplied-air respirator or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear acid-proof gloves, boots, aprons, and gauntlets to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in aluminum, stainless steel, or glass containers on a cement floor in a cool, dry, well-ventilated area away from incompatibles (Sec. 5). Dike around storage tanks with large kirbs or stills to retain the acid in event of leakage. Keep neutralization agents on hand and install a fire hydrant in storage area. (See NFPA Code 43A). **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the eyes, skin, respiratory tract and teeth. Pulmonary function tests (FEV< FVC) are helpful. Educate workers about the hazardous properties of nitric acid.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: *, †, ‡, §, ¥, ψ, ϕ

DOT Hazard Class: 8

ID No.: UN1826 (*†), UN1796 (‡§), UN2031 (¥ψ), UN2032 (ϕ)

DOT Packing Group: I (†§¥ϕ), II (*‡ψ)

DOT Packaging Label: Corrosive (*‡¥ψ), Corrosive, Oxidizer (†§), Corrosive, Oxidizer, Poison (ϕ)

Special Provisions (172.102): B2, T12, T27 (*); T12, T27 (†); B2, T12, T27 (‡); T12, T27 (§); B12, B53, T9, T27 (¥); B2, B12, B53, T9, T27(ψ); 2, B9, B32, B74, T38, T43, T45(ϕ)

Packaging Authorizations

a) Exceptions: None

b) Non-bulk Packaging: 173.158 (*†‡§¥ψ), 173.227 (ϕ)

c) Bulk Packaging: 173.242 (*‡ψ), 173.243 (†§¥), 173.244(ϕ)

Quantity limitations

a) Passenger Aircraft or Railcar: Forbidden

b) Cargo Aircraft Only: 30L (*‡ψ), 2.5L (†§¥), Forbidden (ϕ)

Vessel Stowage Requirements

a) Vessel stowage: D

b) Other: 40(*); 40, 66, 89 (†); 40 (‡); 40, 66, 89 (§); 110, 111 (¥); 110, 111 (ψ); 40, 66, 74, 89, 90, 95 (ϕ)

* Nitrating acid mixtures spent, < 50% HNO_3

† Nitrating acid mixtures spent, > 50% HNO_3

‡ Nitrating acid mixtures, < 50% HNO_3

§ Nitrating acid mixtures, > 50% HNO_3

¥ Nitric acid other than red fuming, > 70% HNO_3

ψ Nitric acid other than red fuming, < 70% HNO_3

ϕ Nitric acid, red fuming.

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 136, 139, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 175

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheet Collection

Coal Tar Creosote

MSDS No. 757

Date of Preparation: 7/91 Revision: A, 9/97

Section 1 - Chemical Product and Company Identification 50

Product/Chemical Name: Coal tar creosote
Chemical Formula: Not found; consists of many compounds and the composition depends on the coal used to make the tar and the design and operating conditions of the coke oven and still.
CAS Number: 8001-58-9
Synonyms: AWPA #1; brick oil; Caswell No. 225; coal tar oil; creosote; creosote oil; creosote P1; creosotum; cresylic creosote; heavy oil; liquid pitch oil; naphthalene oil; Preserv-o-sote; Sakresote; tar oil; wash oil
Derivation: By distillation of coal tar produced by high-temperature carbonization of bituminous coal; by mixing strained naphthalene oil, wash oil, and strained or light anthracene oil; as a by-product of conventional coal coking.
General Use: Used mainly as a wood preservative for railroad ties, poles, fence posts, marine pilings, and other lumber for outdoor use; as a water-proofing agent, fuel oil constituent, frothing agent for mineral separation, tap hole refractory cement, and lubricant for die molds. Used only in limited quantities as an animal and bird repellent, animal dip, and insecticide (ovicide).
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Coal tar creosote consists of aromatic hydrocarbons, anthracene, naphthalene, and phenanthrene derivatives; some tar acids; and tar bases. Polycylic aromatic hydrocarbons make up at least 75%.* (198)

OSHA PEL†	NIOSH REL†	DFG (Germany) MAK
8-hr TWA: 0.2 mg/m^3	0.1 mg/m^3 (cyclohexane-extractable fraction) Carcinogen	None established
ACGIH TLV†	**IDLH Level†**	
TWA: 0.2 mg/m^3	80 mg/m^3	

* Creosote contains several carcinogenic polycyclic aromatic hydrocarbons including benz[a]anthracene, benzo[a]pyrene, and dibenz[a,h]anthracene.
† Coal tar pitch volatiles, as benzene solubles (CAS No. 65996-93-20)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Coal tar creosote is a colorless (pure) or yellow to black (industrial) liquid with an aromatic smoky smell. It is irritating to the eyes, skin and respiratory tract and can be corrosive, causing severe burns. Coal tar creosote is a probable human carcinogen. It is a combustible liquid that is a moderate fire hazard when exposed to an ignition source.

Wilson Risk Scale	
R	1
I	3
S	3
K	2

* Skin absorption

HMIS	
H	3†
F	2
R	0
PPE‡	

†Chronic effects
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin absorption, and skin and/or eye contact
Target Organs: Eyes, skin, bladder, kidneys, and respiratory system
Acute Effects *Note! Phenol and phenolic derivatives of various aromatic hydrocarbons (tar acids), present in low concentrations, are the constituents most likely to be responsible for acute toxicity.*
Inhalation: Inhalation of vapors causes moderate irritation to the nose, throat, and upper respiratory tract.
Eye: Contact with liquid causes conjunctivitis (inflammation of the eye's lining), keratitis (corneal inflammation), or corneal burns with scarring. May cause loss of vision.
Skin: Contact causes irritation, burning, itching, redness, pigment changes, dermatitis (a rash of redness and bumps), or burns. Photosensitization (worsening of rash with exposure to sunlight) may occur.
Ingestion: Causes salivation, nausea; vomiting; gastrointestinal tract irritation or bleeding; abdominal pain; rapid, thready pulse; vertigo; headaches; loss of pupillary reflexes; hypothermia; cyanosis; respiratory distress; shock and mild convulsions. Large doses may be fatal.
Carcinogenicity: IARC classifies coal tar creosote as Group 2A: probably carcinogenic to humans: limited human evidence, sufficient animal evidence. NTP classifies coal tar creosote as Group 2B: sufficient evidence of carcinogenicity from studies in experimental animals. OSHA does not specifically classify coal tar creosote as a carcinogen. NIOSH classifies coal tar pitch volatiles, as benzene solubles, as a carcinogen defined with no further categorization.
Medical Conditions Aggravated by Long-Term Exposure: Skin disorders.
Chronic Effects: Include dermatitis and, possibly, skin cancer or other forms of cancer. An increased risk of scrotal cancer for creosote-exposed brick makers was indicated in a worker mortality analysis. Epidemiological studies of coke oven workers reveal increased incidences of lung, bladder, prostate, pancreas, and intestinal cancer.

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Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air, monitor for respiratory distress, and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.
Skin Contact: *Quickly* remove contaminated clothing. Prior to washing and if readily available, use undiluted polyethylene glycol 300 to 400. Wash affected area with soap and flooding amounts of water for at least 15 min. *Do not* rub or apply pressure to the affected skin, apply any oily substance or use hot water to rinse. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Rinse the mouth several times with cold water. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water. *Do not induce vomiting!* Keep victim warm and at rest.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Creosote may be detected in urine.
Special Precautions/Procedures: An exposed person should examine their skin periodically for growths, changes in warts or moles, and sores that do not heal.

Section 5 - Fire-Fighting Measures



Flash Point: 165.2 °F (74 °C)
Flash Point Method: CC
Autoignition Temperature: 637 °F (336 °C)
LEL: None reported.
UEL: None reported.
Flammability Classification: OSHA IIIA combustible liquid
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or regular foam. For large fires, use water spray, fog or regular foam.
Unusual Fire or Explosion Hazards: Coal tar creosote may present a vapor explosion hazard indoors, outdoors, and in sewers. Vapors may travel to an ignition source and flash back.
Hazardous Combustion Products: Include carbon oxides.
Fire-Fighting Instructions: If feasible and without undue risk, remove containers from fire hazard area. Otherwise use water spray to cool fire-exposed containers until well after they are extinguished. *Do not* release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Immediately leave area if you hear a rising sound from venting safety device or notice any fire-caused tank discoloration as a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Isolate area for 1/2 mile in all directions if fire involves tank, rail car or tank truck. Fully decontaminate or properly dispose of personal protective clothing.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel. Isolate hazard area, deny entry, and stay upwind of spills. Shut off all ignition sources. Cleanup personnel should protect against vapor inhalation and skin and eye contact.
Small Spills: Take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal.
Large Spills
Containment: Consider initial downwind evacuation for at least 300 meters (1000 feet). For large spills, dike far ahead of liquid spill for later disposal. Water spray may reduce vapor. *Do not* release into sewers or waterways.
Cleanup: Use nonsparking tools.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor inhalation and skin and eye contact. Use ventilation sufficient to reduce airborne exposures to nonhazardous levels (Sec. 2). Wear protective gloves, goggles, and clothing to avoid contact. Wear respiratory protection when necessary (Sec. 8). Consult your industrial hygienist. Practice good personal hygiene procedures to avoid inadvertently ingesting this material. Keep away from ignition sources.
Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and ignition sources. Store coal tar creosote as close to area of use as possible to minimize transporting distance. Avoid physical damage to containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all operations and/or ventilate at the site of release to avoid vapor dispersion into the work area. To prevent static sparks, electrically ground and bond all containers and equipment.

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Ventilation: Provide general or local exhaust ventilation systems equipped with high-efficiency particulate filters to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. (103)

Administrative Controls: Preplacement and periodic medical examinations of exposed workers emphasizing respiratory, skin, liver, and kidney disorders, including comprehensive work and medical history, physical examination, CXR, PFTs, urinalysis, LFT, and sputum cytology as the attending physician considers appropriate. Educate workers about the health and safety hazards associated with coal tar creosote.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. (The following respirator recommendations are for coal tar pitch volatiles.) For concentrations above the NIOSH REL or at any detectable concentrations, wear a SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; or any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent any skin contact. With breakthrough times of >8 hr, butyl rubber, Teflon™, and Viton™ are recommended materials. Frequent change of protective garments is an additional protective measure. Wear protective eyeglasses or chemical safety goggles and face shield, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Oily liquid

Appearance and Odor: Colorless (pure) or yellow to black (industrial); aromatic smoky smell

Specific Gravity (H_2O=1, at 4 °C): 1.07 to 1.08 at 68 °F (20 °C)

Water Solubility: Slightly soluble

Other Solubilities: Soluble in alcohol; ether; glycerin; dimethyl sulfate; fixed or volatile oils; in solution of fixed alkali hydroxides.

Boiling Point Range: 381 to 752 °F (194 to 400 °C)

Octanol/Water Partition Coefficient: log K_{ow} = 1.0

Heat of Combustion: -12,500 Btu/lb; -6,900 cal/g

Section 10 - Stability and Reactivity

Stability: Coal tar creosote is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Creosote oil mixed with chlorosulfonic acid in a closed container causes an increase in temperature and pressure.

Conditions to Avoid: Avoid excessive heat and contact with chlorosulfonic acid.

Hazardous Decomposition Products: Thermal oxidative decomposition of coal tar creosote can produce carbon oxides and thick, black, acrid smoke.

Section 11 - Toxicological Information

Toxicity Data:*

Genetic Effects:

S. typhimurium: 20 µg/plate (-S9) produced mutations.

Hamster, ovary cell: 10 mg/L induced sister chromatid exchange.

Reproductive Effects:

Mouse, oral: 2 g/kg administered on gestational days 5-9 produced maternal effects and fetotoxicity.

Acute Oral Effects:

Rat, oral, LD_{50}: 725 mg/kg

Mouse, oral, LD_{50}: 433 mg/kg

Tumorigenicity: Mouse, skin, 99 g/kg/33 weeks administered intermittently produced tumors on skin and appendages (carcinogenic by RTECS criteria).

* See NIOSH, *RTECS* (GF8615000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: TL_{50}, goldfish (*Carassius auratus*), 3.51 ppm/24 hr (60:40) mixture of creosote and coal tar; TL_{50}, rainbow trout (*Salmo gairdneri*), 3.72 ppm/24 hr (60:40) mixture of creosote and coal tar; LD_{50}, bob white quail (*Colinus virginianus*), 1,260 ppm/8 days (60:40) mixture of creosote and coal tar.
Environmental Fate: Data not found.

Section 13 - Disposal Considerations

Disposal: Coal tar creosote is a good candidate for rotary kiln and fluidized bed incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
Container Cleaning and Disposal: Handle empty containers carefully as hazardous residues may still remain.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Corrosive liquids, n.o.s.
Shipping Symbols: Not listed.
Hazard Class: 8
ID No.: UN1760
Packing Group: I, II, or III*
Label: CORROSIVE
Special Provisions: A7, B10, T42†; B2, T14 ‡; T7 §

Packaging Authorizations
a) Exceptions: None †; 173.154 ‡ §
b) Non-bulk Packaging: 173.201†; 173.202‡; 173.203§
c) Bulk Packaging: 173.243†; 173.242‡; 173.241§

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 0.5 L†; 1 L‡; 5 L§
b) Cargo Aircraft Only: 2.5 L†; 30 L‡; 60 L§

Vessel Stowage Requirements
a) Vessel Stowage: B†; B‡; A§
b) Other: 40†‡§

* See 49 CFR 173.137 to assign Packing Group. Data was not available for Genium to make this determination.
† Packing Group I
‡ Packing Group II
§ Packing Group III

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Material No. U051
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) listed specific per RCRA, Sec. 3001
CERCLA Final Reportable Quantity (RQ), 1 lb (0.454 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed (as coal tar pitch volatiles) as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
Listed as an OSHA Specifically Regulated Substance (29 CFR 1910.1002; interpretation of term)

Section 16 - Other Information

References: 73, 103, 124, 136, 139, 184, 196, 197, 198, 200, 209 W5-MAC

Prepared By ..... J Sawyer, MS/MJ Wurth, BS
Industrial Hygiene Review ..... DJ Wilson, CIH
Medical Review ..... G Kelafant, MD

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Material Safety Data Sheets Collection:

Sheet No. 789
Cyanide

Issued: 11/91

Section 1. Material Identification

Cyanide (CN^-) Description: Derived by combining a carbon ion with a nitride ion. Used in rat and pest poisons, silver and metal polishes, photographic solutions, fumigating products, and electroplating solutions. Cyanide may also be liberated in burning of plastics, natural fabrics (wool or silk), polyurethane bedding or furniture, acrylic baths, nylon carpets, and melamine resin insulation.

Other Designations: CAS No. 57-12-5, carbon nitride ion, cyanide anion, isocyanide.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*™ for a suppliers list.

Cautions: Cyanide is severely toxic by all routes of entry and its lethal dose is an estimated 1 µg/ml. Take necessary precautions to avoid all possible exposure to this material.

R	1
I	4
S	2
K	1

Genium: 1 / 4 1 / -

HMIS
H 4
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Cyanide, ca 100%

1990 OSHA PEL (Skin)
STEL: 4.7 ppm, 5 mg/m³, as hydrogen cyanide (gas)

1991-92 ACGIH TLV (Skin)
Ceiling: 10 ppm, 11 mg/m³, as hydrogen cyanide (gas)

1990 DFG (Germany) MAK (*Danger of cutaneous absorption*)
TWA: 10 ppm, 11mg/m³ as hydrogen cyanide (gas)

1990 IDLH Level
50 mg/m³

1990 NIOSH REL (Skin)
STEL: 4.7 ppm, 5 mg/m³ as hydrogen cyanide (gas)

1985-86 Toxicity Data*
Mouse, intraperitoneal, LD_{50}: 3 mg/kg; toxic effects not yet reviewed

* See NIOSH, *RTECS* (GS7175000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Varies with specific CN^- compound
Melting Point: Varies with specific CN^- compound
Molecular Weight: 26.02
Density: Varies with specific CN^- compound
Water Solubility: Varies with specific CN^- compound

Appearance and Odor: Varies with specific CN^- compound, but usually has an almond odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Cyanide is combustible. For small fires, use dry chemical, water spray or foam. *Do not use carbon dioxide (CO_2)!* For large fires, use water spray, fog, or regular foam. *Do not scatter* material with more water than needed to extinguish fire.

Unusual Fire or Explosion Hazards: Combustible by chemical reaction with heat, moisture, or acid. Many cyanides readily evolve hydrogen cyanide (HCN), a toxic flammable gas.

Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing *is ineffective* for fires involving cyanide. Wear chemical protective clothing that the shipper or manufacturer specifically recommends. If possible without risk, remove container from fire area. Fight fire from maximum distance. Stay away from ends of tanks. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Remove and isolate contaminated clothing at the site.

Section 5. Reactivity Data

Stability/Polymerization: Cyanide is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Cyanide may react violently with hypochlorite solutions at pH 10 to 10.3, is explosive with nitrites if heated above 450 °C, and is incompatible with chlorates, fluorine, magnesium, nitrates, and all inorganic acids.

Conditions to Avoid: Avoid exposure to heat and contact with incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of cyanide can produce carbon dioxide and toxic, flammable vapors of CN^-.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA do not list cyanide as a carcinogen.

Summary of Risks: Cyanide is a potent, fast-acting, chemical asphyxiant (material which causes pulse and breathing obstruction) that prevents tissue utilization of oxygen by inhibiting the enzyme involved (cytochrome oxidase). Death can occur within seconds to minutes after inhalation of some cyanide gases, and may take as long as an hour after ingestion of a large amount of a cyanide salt due to a slower absorption. Toxicity is dependent on the form of cyanide the victim is exposed to. Mortality from acute exposures is high, but recovery is generally complete in nonfatal cases.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Continue next page

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Section 6. Health Hazard Data, *continued*

Target Organs: Brain, heart, lungs, skin, blood.
Primary Entry Routes: Inhalation, ingestion, skin absorption.
Acute Effects: Inhalation of cyanide gases may cause rapid toxicity where the victim may only have time to utter a warning cry before succumbing to unconsciousness caused by asphyxiation. If exposure is small there may be a weak, rapid, irregular heartbeat with bright-pink coloration of the skin due to high oxyhemoglobin content in the veins before person loses consciousness. A telltale sign of inhalation or ingestion is the odor of bitter almonds on the breath, however up to half the population is genetically unable to detect this smell. Dialated pupils are common in severe poisonings. Contact with broken skin can cause cyanide absorption into the bloodstream. Cyanide ingestion can cause a bitter, burning taste, salivation, nausea, vomiting, anxiety, confusion, vertigo (dizziness), giddiness, sensation of stiffness in the lower jaw, and dyspnea (difficult respiration). In severe cases symptoms could progress to convulsions, paralysis, coma, cardiac arrhythmias, followed by death due to respiratory failure.
Chronic Effects: Chronic skin contact may cause cyanide rash, characterized by itching, and macular (blotches), papular (small, solid, conical, elevation of the skin), and vesicular (blister-like) eruptions. Chronic cyanide inhalation may cause appetite loss, headache, weakness, nausea, dizziness, and symptoms of irritation of the upper respiratory tract and eyes. Other symptoms of chronic exposure include goiter, B12 and folate abnormalities, chest discomfort, epistaxis (nose bleed), poor appetite and sleeping, and functional changes in hearing.
FIRST AID: *Emergency personnel should protect against contamination!*
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Speed is extremely important. Rinse with flooding amounts of water for at least 15 min. Wash exposed area *extremely thoroughly* with soap and water. If irritation and pain persist, consult a physician.
Inhalation: Remove exposed person to fresh air and immediately begin administering 100% oxygen. Avoid mouth-to-mouth resuscitaton during CPR to prevent self-poisonings.
Ingestion: Obtain and prepare the Lilly cyanide antidote kit [Eli Lilly Co. (Stock No. M76)] for use in symptomatic patients. Never give anything by mouth to an unconscious or convulsing person. Do not induce vomiting with Ipecac syrup. Consider gastric lavage. Activated charcoal is said to be ineffective.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: If the victim is unconscious, bradycardia and absence of cyanosis may be key diagnostic signs. Consider administration of amyl nitrite followed by sodium nitrite and sodium thiosulfate (antidote kit). Consider use of 100% oxygen.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources—no flames, flares, or smoking in hazard area. Cleanup personnel should wear fully encapsulating, vapor-protective clothing for spills or leaks without fire. For small dry spills, carefully scoop into clean, dry, suitable container and cover loosely. For small solution spill, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers. For large spills, dike far ahead of solution spills for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): Hazardous Waste No. P030
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity: *An RQ is not being assigned to the general class* [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Select the respirator based on its suitability provide adequate worker protection for the given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact.
Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Cyanide detoxifying kits and instructions should be available in use areas. Instruct employees working in these areas on how and when to use these kits.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in tightly closed and properly labeled containers in cool, dry, well-ventilated area away from heat and incompatibles.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control hazardous airborne contaminants and to maintain concentrations at the lowest practical level.
Other Precautions: If respirators are used, implement a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Consider preplacement and periodic medical examinations of exposed workers that emphasize the heart, blood, and respiratory system.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Cyanide *or* cyanide mixture, dry
DOT Hazard Class: Poison B
ID No.: UN1588
DOT Label: Poison
DOT Packaging Exceptions: 173.364
DOT Packaging Requirements: 173.370

IMO Shipping Name: Cyanides, inorganic, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN1588
IMO Label: Poison
IMDG Packaging Group: I/II; Stow 'away from' acids

MSDS Collection **References:** 73, 101, 103, 126, 127, 136, 143, 146, 148, 153, 159, 161, 163
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

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MATERIAL SAFETY DATA SHEET: CRYSTAL SIMPLE GREEN®

I. PRODUCT & COMPANY INFORMATION

PRODUCT NAME: **CRYSTAL SIMPLE GREEN®**
OTHER NAMES: **CRYSTAL SIMPLE GREEN® - SPECIALIZED CLEANER / DEGREASER**
SIMPLE GREEN SAFETY TOWELS (fluid only)

COMPANY NAME: **SUNSHINE MAKERS, INC.**
15922 Pacific Coast Highway
Huntington Harbour, CA 92649 USA
Telephone: 800-228-0709 • 562-795-6000
Fax: 562-592-3034
Website: www.simplegreen.com

Version No. 4006
Issue Date: January 2002

For 24-hour emergency, call Chem-Tel, Inc.: 800-255-3924

USE OF PRODUCT: A specialized cleaner and degreaser for use in the industrial and institutional workplace..

II. INGREDIENT INFORMATION

The only ingredient of Crystal Simple Green® with established exposure limits is undiluted 2-butoxyethanol (<6%) (Butyl Cellosolve; CAS No. 111-76-2): the OSHA PEL and ACGIH TLV is 25 ppm (skin). Note, however, that Butyl Cellosolve is only one of the raw material ingredients that undergo processing and dilution during the manufacture of Crystal Simple Green®. Upon completion of the manufacturing process, Crystal Simple Green® does not possess the occupational health risks associated with exposure to undiluted Butyl Cellosolve. Verification of this is contained in the independent test results detailed under "Toxicological Information" on Page 3 of this MSDS.

The Butyl Cellosolve in Crystal Simple Green® is part of a chemical category (glycol ethers) regulated by the Emergency Planning and Community Right-to-Know Act (SARA, Title III, section 313); therefore, a reporting requirement exists. Based upon chemical analysis, Crystal Simple Green® contains no known EPA priority pollutants, heavy metals, or chemicals listed under RCRA, CERCLA, or CWA. Analysis by TCLP (Toxicity Characteristic Leaching Procedure) according to RCRA revealed no toxic organic or inorganic constituents.

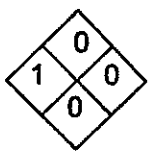
All components of Crystal Simple Green® are listed on the TSCA Chemical Substance Inventory.

III. HAZARDS IDENTIFICATION

UN Number: Not required
Dangerous Goods Class: Nonhazardous

Hazard Rating (NFPA/HMIS)

Health = 1* Reactivity = 0
Fire = 0 Special = 0



Rating Scale

0 = minimal 1 = slight
2 = moderate 3 = serious
4 = severe

*Mild eye irritant, non-mutagenic and non-carcinogenic. **None of the ingredients in Crystal Simple Green® are regulated or listed as potential cancer agents by Federal OSHA, NTP, or IARC.**

IV. FIRST AID MEASURES

SYMPTOMS OF OVEREXPOSURE AND FIRST AID TREATMENT

Eye contact: Reddening may develop. Immediately rinse the eye with large quantities of cool water; continue 10-15 minutes or until the material has been removed; be sure to remove contact lenses, if present, and to lift upper and lower lids during rinsing. Get medical attention if irritation persists.

Skin contact: Minimal effects, if any; rinse skin with water, rinse shoes and launder clothing before reuse. Reversible reddening may occur in some dermal-sensitive users; thoroughly rinse area and get medical attention if reaction persists.

Swallowing: Essentially non-toxic. Give several glasses of water to dilute; do not induce vomiting. If stomach upset occurs, consult physician.

Inhalation: Non-toxic. Exposures to concentrate-mist may cause mild irritation of nasal passages or throat; remove to fresh air. Get medical attention if irritation persists.

V. FIRE FIGHTING MEASURES

Crystal Simple Green® is stable, not flammable, and will not burn.

Flash Point/Auto-Ignition:	Not flammable.
Flammability Limits:	Not flammable.
Extinguishing Media:	Not flammable/nonexplosive. No special procedures required.
Special Fire Fighting Procedures:	None required.

VI. ACCIDENTAL RELEASE MEASURES

Recover usable material by convenient method; residual may be removed by wipe or wet mop. If necessary, unrecoverable material may be washed to drain with large quantities of water.

VII. HANDLING, STORAGE & TRANSPORT INFORMATION

No special precautions are required. **This product is non-hazardous for storage and transport according to the U.S. Department of Transportation Regulations.** Crystal Simple Green® requires no special labeling or placarding to meet U.S. Department of Transportation requirements.

UN Number:	Not required
Dangerous Goods Class:	Nonhazardous

VIII. EXPOSURE CONTROLS

Exposure Limits: The Crystal Simple Green® formulation presents no health hazards to the user when used according to label directions for its intended purposes. Mild skin and eye irritation is possible (please see Eye contact and Skin contact in Section IV.).

Ventilation: No special ventilation is required during use. Large-scale uses indoors should provide an increased rate of air exchange.

Human Health Effects or Risks from Exposure: Adverse effects on human health are not expected from Crystal Simple Green®, based upon twenty years of use of Simple Green without reported adverse health incidence in diverse population groups, including extensive use by inmates of U.S. Federal prisons in cleaning operations.

Crystal Simple Green® is a mild eye irritant; mucous membranes may become irritated by concentrate-mist.

Crystal Simple Green® is not likely to irritate the skin in the majority of users. Repeated daily application to the skin without rinsing, or continuous contact of Crystal Simple Green® on the skin may lead to temporary, but reversible, irritation.

Medical Conditions Aggravated by Exposure: No aggravation of existing medical conditions is expected; dermal-sensitive users may react to dermal contact by Crystal Simple Green®.

IX. PERSONAL PROTECTION

Precautionary Measures: No special requirements under normal use conditions.
Eye Protection: Caution, including reasonable eye protection, should always be used to avoid eye contact where splashing may occur.
Skin Protection: No special precautions required; rinse completely from skin after contact.
Respiratory Protection: No special precautions required except during large-scale spray applications where spray mist levels are high.
Work and Hygienic Practices: Wash or rinse hands before touching eyes or contact lenses. Follow standard hygienic practices for handling cleaning agents.

X. PHYSICAL AND CHEMICAL PROPERTIES

Appearance/odor::	Clear liquid	Vapor Pressure:	18 mm Hg @ 20 °C; 23.5 mm Hg @ 26 °C
Specific Gravity:	1.020	Vapor Density:	1.3 (air = 1)
pH of concentrate:	9.35	Density:	8.5 lbs./gallon
Evaporation:	>1 (butyl acetate = 1)		
Boiling Point:	100.6 °C (212 °F)		
Freezing Point:	-9 °C (16 °F) If product freezes, it will reconstitute without loss of efficacy when brought back to room temperature and agitated.		

VOC Composite Partial Pressure: 0 mm Hg @ 20 °C
Volatile Organic Compounds (VOCs): 0 g/L per ASTM Method D-2369. Per California AQMD's VOC test method, product must be diluted at least 2 parts of water to 1 part Crystal Simple Green® in order to meet SCAQMD Rule 1171 & Rule 1122 and BAAQMD Regulation 8-16 VOC requirements for solvent cleaning operations.
Water Solubility: Completely soluble in water.
Detection: Crystal Simple Green® has a characteristic odor that is not indicative of any hazardous situation.

XI. STABILITY AND REACTIVITY INFORMATION

Nonreactive. Crystal Simple Green® is stable, even under fire conditions, and will not react with water or oxidizers. Hazardous polymerization will not occur.

XII. TOXICOLOGICAL INFORMATION

The information and conclusions cited in this section are based on data and testing of Simple Green®. The data are directly applicable to Crystal Simple Green® because, except for the fragrance and dyes which have been removed, it contains the same ingredients as Simple Green®.

Nonhuman Toxicity

Acute Mortality Studies:
Oral LD_{50} (rat): >5.0 g/kg body weight // Dermal LD_{50} (rabbit): >2.0 g/kg body weight

Dermal Irritation: Only mild, but reversible, irritation was found in a standard 72-hr test on rabbits. A value of 0.2 (non-irritating) was found on a scale of 8.

Eye Irritation: With or without rinsing with water, the irritation scores in rabbits at 24 hours did not exceed 15 (mild irritant) on a scale of 110.

Subchronic dermal effects: No adverse effects, except reversible dermal irritation, were found in rabbits exposed to Simple Green® (up to 2.0 g/kg/day for 13 weeks) applied to the skin of 25 males and 25 females. Only female body weight gain was affected. Detailed microscopic examination of all major tissues showed no adverse changes.

Fertility Assessment by Continuous Breeding: The Simple Green® formulation had no adverse effect on fertility and reproduction in CD-1 mice with continuous administration for 18 weeks, and had no adverse effect on the reproductive performance of their offspring.

XIII. BIODEGRADABILITY AND ENVIRONMENTAL TOXICITY INFORMATION

Biodegradability:

Like Simple Green®, Crystal Simple Green® is readily decomposed by naturally occurring microorganisms. The biological oxygen demand (BOD), as a percentage of the chemical oxygen demand (COD), after 4, 7, and 11 days was 56%, 60%, and 70%, respectively. Per OECD Closed Bottle Test, Crystal Simple Green® meets OECD and EPA recommendations for ready biodegradability.

In a standard biodegradation test with soils from three different countries, Butyl Cellosolve reached 50% degradation in 6 to 23 days, depending upon soil type, and exceeded the rate of degradation for glucose, which was used as a control for comparison.

Environmental Toxicity Information:

Crystal Simple Green® is considered practically non-toxic per EPA's aquatic toxicity scale.

XIV. DISPOSAL CONSIDERATIONS

Crystal Simple Green® is fully water soluble and biodegradable and will not harm sewage-treatment microorganisms if disposal by sewer or drain is necessary. Dispose of in accordance with all applicable local, state, and federal laws.

XV. OTHER INFORMATION

Containers:	Crystal Simple Green® residues can be completely removed by rinsing with water; the container may be recycled or applied to other uses.
Contact Point:	Sunshine Makers, Inc., Research and Development Division: 562-795-6000.

***** NOTICE *****

All information appearing herein is based upon data obtained by the manufacturer and recognized technical sources. Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of this information, Sunshine Makers, Inc. or its distributors extends no warranties, makes no representations and assumes no responsibility as to the suitability of such information for application to purchaser's intended purposes or for consequences of its use.

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Fuel Oil No. 4

MSDS No. 886

Date of Preparation: 10/93

Section 1 - Chemical Product and Company Identification 42

Product/Chemical Name: Fuel Oil No. 4
Chemical Formula: Not given
CAS No.: 68476-31-3
Synonyms: heating oil
Derivation: A petroleum fraction consisting of heavier straight-run or cracked distillates.
General Use: Used in commercial or industrial burner installations not equipped with preheating facilities.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Fuel Oil No. 4, ca 100 % vol
Trace Impurities: All petroleum fractions contain appreciable amounts of aromatics (toluene, xylene) and saturated rings (cycloparaffins, naphthenes).

OSHA PEL
None established

NIOSH REL
None established

DFG (Germany) MAK
None established

ACGIH TLV
None established

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Fuel oil no. 4 is a moderately dark, viscous liquid. It is flammable when exposed to heat or flame. Prolonged or repeated skin contact may cause dermatitis. It is a DOT flammable liquid.

Wilson Risk Scale
R 1
I -
S 1
K 2

HMIS
H 1
F 2
R 0

PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion.
Target Organs: Skin, CNS (severe exposure).
Acute Effects
Inhalation: Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, increased rate of respiration, tachycardia (excessively rapid heart beat), stupor, convulsions, cyanosis (dark purplish coloration of the skin and mucous membranes caused by deficient blood oxygenation), or unconsciousness, depending on concentration and length of exposure.
Eye: None reported.
Skin: Prolonged or repeated skin contact may cause irritation of the hair follicles and may block the sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Ingestion: Ingestion may cause nausea, vomiting, diarrhea, and abdominal pain; occasionally, mild CNS depression or excitement occur after ingestion.
Carcinogenicity: IARC lists fuel oils, residual heavy as a possible carcinogen (2B; limited animal data). OSHA and NTP do not list fuel oil no. 4 as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Dermatitis.
Chronic Effects: Repeated skin contact may cause defatting and dermatitis.
Comments: Fuel oil no. 4 may be a synergist to pesticides.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of tepid water for at least 15 min. If pain and irritation persist, consult an ophthalmologist.
Skin Contact: Remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, *do not* induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Comments: Following ingestion of hydrocarbons, the primary concern is aspiration into the lungs. Hydrocarbons with the lowest viscosity and surface tension have the greatest risk for aspiration. Fuel oil no. 4 is a viscous liquid and therefore, has a lesser risk for aspiration. Risk for vapor inhalation of fuel oil no. 4 is less than other hydrocarbons such as gasoline or kerosene because fuel oil no. 4 is less volatile. In general, fuel oil no. 4 is more viscous and less toxic than kerosene.

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Section 5 - Fire-Fighting Measures

Flash Point: 142-240 °F (61-116 °C): reported by NFPA; 129 °F (54 °C)

NFPA



Autoignition Temperature: 505 °F (263 °C)
LEL: None reported.
UEL: None reported.
Flammability Classification: Depending on the flash point, fuel oil no. 4 is classified as an OSHA Class II, Class IIIA or IIIB Combustible Liquid.*
Extinguishing Media: For small fires, use dry chemical, CO_2, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: Containers may explode in the heat of fire.
Hazardous Combustion Products: Acrid smoke and irritating fumes.
Fire-Fighting Instructions: If feasible and without undue risk, move containers from fire hazard area. Otherwise, apply cooling water to containers until well after fire is extinguished. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device due to fire. For massive fires, use monitor nozzles or unmanned hose holders. Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection.
* You will notice that there is a difference in classifications of a flammable and combustible liquid between OSHA and the DOT. The DOT classifies fuel oil (no. 1, 2, 4, 5, 6) as flammable liquids (See Sec. 14).

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of large spills, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Clean up spills promptly to reduce fire hazards. Use nonsparking tools.
Small Spills: Use an inert, noncombustible, absorbent material to pick up small spills or residues.
Large Spills
Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.
Cleanup: Consider using straw, polyurethane foam, activated carbon, or peat to soak up oil. There is a wide variety of sorbents, dispersants, sinking agents, combustion promoters, and mechanical systems to treat oil spills.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation or prolonged skin contact.
Storage Requirements: Store in closed containers in a well-ventilated area away from heat and ignition sources. No smoking in storage or use areas.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Administrative Controls: Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Barrier creams may be helpful. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

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Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Moderately dark, viscous.
Medium Odor Threshold: 0.5 ppm

Water Solubility: Insoluble
Melting Point: -51 °F (-46 °C)

Section 10 - Stability and Reactivity

Stability: Fuel oil no. 4 is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization cannot occur.
Chemical Incompatibilities: Oxidizing materials.
Conditions to Avoid: Heat and ignition sources.
Hazardous Decomposition Products: Thermal oxidative decomposition of fuel oil no. 4 can produce various hydrocarbons and hydrocarbon derivatives and partial oxidation products including carbon oxides.

Section 11- Toxicological Information

Toxicity Data: None reported*

* Monitor NIOSH, *RTECS* (LS8965000), for future toxicity data.

Section 12 - Ecological Information

Aquatic Toxicity:
Striped bass, LC_{50}, 96 hr: 25.1 ppm (static test environment)
Carp, LC_{50}, 24 hr: 50 ppm (static test environment)
Striped bass, LC_{50}, 96 hr: 0.62 ppm (static test environment with 1.5 mg/L LAS)
Carp, LC_{50}, 24 hr: 5.1 ppm (static with 1.5 mg/L LAS)

Section 13 - Disposal Considerations

Disposal: Consider incineration (permit-approved facilities only). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Fuel oil (No. 1, 2, 4, 5, or 6)
Shipping Symbols: D
Hazard Class: 3
ID No.: NA1993
Packing Group: III
Label: Flammable Liquid*
Special Provisions (172.102): B1

* DOT defines a flammable liquid as a liquid having a flash point at or above 100 °F (37.8 °C) and not more than 141 °F (60.5 °C). OSHA defines a flammable liquid as any liquid having a flash point below 100 °F.

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 60 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: —

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Classified as a RCRA Hazardous Waste (40 CFR 261.21): Characteristic of Ignitability [if flash point <140 °F (60 °C)]
CERCLA Hazardous Substance (40 CFR 302.4): Listed if classified as a RCRA Hazardous Waste, Characteristic of Ignitability
CERCLA Reportable Quantity (RQ), 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

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Section 16 - Other Information

References: 73, 101, 103, 126, 132, 136, 164

Prepared by ..... MJ Wurth, BS
Industrial Hygiene Review ..... DJ Wilson, CIH
Medical Review ..... J Brent, MD, PhD
Revision Notes:

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Material Safety Data Sheets Collection:

Sheet No. 467
Automotive Gasoline, Lead-free

Issued: 10/81 Revision: A, 9/91

Section 1. Material Identification

35

Automotive Gasoline, Lead-free, Description: A mixture of volatile hydrocarbons composed mainly of branched-chain paraffins, cycloparaffins, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal. Motor gasolines are made chiefly by cracking processes, which convert heavier petroleum fractions into more volatile fractions by thermal or catalytic decomposition. Widely used as fuel in internal combustion engines of the spark-ignited, reciprocating type. Automotive gasoline has an octane number of approximately 90. A high content of aromatic hydrocarbons and a consequent high toxicity are also associated with a high octane rating. Some gasolines sold in the US contain a minor proportion of tetraethyllead, which is added in concentrations not exceeding 3 ml per gallon to prevent engine "knock." However, methyl-tert-butyl ether (MTBE) has almost completely replaced tetraethyllead.

R 1
I 2
S 2*
K 4
* Skin absorption

NFPA



HMIS
H 2
F 3
R 1
PPG†
† Sec. 8

Other Designations: CAS No. 8006-61-9, benzin, gasoline, gasolene, motor spirits, natural gasoline, petrol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Inhalation of automotive gasoline vapors can cause intense burning in throat and lungs, central nervous system (CNS) depression, and possible fatal pulmonary edema. Gasoline is a dangerous fire and explosion hazard when exposed to heat and flames.

Section 2. Ingredients and Occupational Exposure Limits

Automotive gasoline, lead-free*

1990 OSHA PELs
8-hr TWA: 300 ppm, 900 mg/m³
15-min STEL: 500 ppm, 1500 mg/m³

1990-91 ACGIH TLVs
TWA: 300 ppm, 890 mg/m³
STEL: 500 ppm, 1480 mg/m³

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 900 ppm/1 hr; toxic effects include sense organs and special senses (conjunctiva irritation), behavioral (hallucinations, distorted perceptions), lungs, thorax, or respiration (cough)
Human, eye: 140 ppm/8 hr; toxic effects include mild irritation
Rat, inhalation, LC_{50}: 300 g/m³/5 min

* A typical modern gasoline composition is 80% paraffins, 14% aromatics, and 6% olefins. The mean benzene content is approximately 1%. Other additives include sulfur, phosphorus, and MTBE.
† See NIOSH, *RTECS* (LX3300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Initially, 102 °F (39 °C); after 10% distilled, 140 °F (60 °C); after 50% distilled, 230 °F (110 °C); after 90% distilled, 338 °F (170 °C); final boiling point, 399 °F (204 °C)
Vapor Density (air = 1): 3.0 to 4.0
Density/Specific Gravity: 0.72 to 0.76 at 60 °F (15.6 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear (gasoline may be colored with dye), mobile liquid with a characteristic odor recognizable at about 10 ppm in air.

Section 4. Fire and Explosion Data

Flash Point: -45 °F (-43 °C)	Autoignition Temperature: 536 to 853 °F (280 to 456 °C)	LEL: 1.3% v/v	UEL: 6.0% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or alcohol foam as extinguishing media. Use of water may be ineffective to extinguish fire, but use water spray to knock down vapors and to cool fire-exposed drums and tanks to prevent pressure rupture. Do not use a solid stream of water since it may spread the fuel.
Unusual Fire or Explosion Hazards: Automobile gasoline is an OSHA Class IB flammable liquid and a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow to an ignition source and flash back. Automobile gasoline can also react violently with oxidizing agents.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode, and full protective clothing. When the fire is extinguished, use nonsparking tools for cleanup. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Automotive gasoline is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Automotive gasoline can react with oxidizing materials such as peroxides, nitric acid, and perchlorates.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of automotive gasoline can produce oxides of carbon and partially oxidized hydrocarbons.

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Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC list gasoline as a possible human carcinogen (Group 2B). Although the IARC has assigned an overall evaluation to gasoline, it has not assigned an overall evaluation to specific substances within this group (inadequate human evidence).
Summary of Risks: Gasoline vapors are considered moderately poisonous. Vapor inhalation can cause central nervous system (CNS) depression and mucous membrane and respiratory tract irritation. Brief inhalations of high concentrations can cause a fatal pulmonary edema. Reported responses to gasoline vapor concentrations are: 160 to 270 ppm causes eye and throat irritation in several hours; 500 to 900 ppm causes eye, nose, and throat irritation, and dizziness in 1 hr; and 2000 ppm produces mild anesthesia in 30 min. Higher concentrations are intoxicating in 4 to 10 minutes. If large areas of skin are exposed to gasoline, toxic amounts may be absorbed. Repeated or prolonged skin exposure causes dermatitis. Certain individuals may develop hypersensitivity. Ingestion can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonitis. In adults, ingestion of 20 to 50 g gasoline may produce severe symptoms of poisoning.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eye, respiratory and central nervous systems.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Acute inhalation produces intense nose, throat, and lung irritation; headaches; blurred vision; conjunctivitis; flushing of the face; mental confusion; staggering gait; slurred speech; and unconsciousness, sometimes with convulsions. Ingestion causes inebriation (drunkenness), vomiting, dizziness, fever, drowsiness, confusion, and cyanosis (a blue to dark purplish coloration of skin and mucous membrane caused by lack of oxygen). Aspiration causes choking, cough, shortness of breath, increased rate of respiration, excessively rapid heartbeat, fever, bronchitis, and pneumonitis. Other symptoms following acute exposure include acute hemorrhage of the pancreas, fatty degeneration of the liver and kidneys, and passive congestion of spleen.
Chronic Effects: Chronic inhalation results in appetite loss, nausea, weight loss, insomnia, and unusual sensitivity (hyperesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blistering, drying, and lesions.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Give conscious victim a mixture of 2 tablespoons of activated charcoal mixed in 8 oz of water to drink. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Use nonsparking tools. Take up small spills with sand or other noncombustible adsorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).
Aquatic Toxicity: Bluegill, freshwater, LC_{50}, 8 ppm/96 hr.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. There are no specific NIOSH recommendations. However, for vapor concentrations not immediately dangerous to life or health, use chemical cartridge respirator equipped with organic vapor cartridge(s), or a supplied-air respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Materials such as neoprene or polyvinyl alcohol provide excellent/good resistance for protective clothing. **Note:** Resistance of specific materials can vary from product to product.
Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IB liquid. Outside or detached storage preferred.
Engineering Controls: Avoid vapor inhalation and skin or eye contact. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Indoor use of this material requires explosion-proof exhaust ventilation to remove vapors. Only use gasoline as a fuel source due to its volatility and flammable/explosive nature. Practice good personal hygiene and housekeeping procedures. Wear clean work clothing daily.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Gasoline (*including casing-head and natural*)
DOT Hazard Class: Flammable liquid
ID No.: UN1203
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Gasoline
IMO Hazard Class: 3.1
ID No.: UN1203
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146, 153, 159
Prepared by: M Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheet Collection

Fuel Oil No. 2 **MSDS No. 469**

Date of Preparation: 10/81 Revision: B, 3/98

Section 1 - Chemical Product and Company Identification 51

Product/Chemical Name: Fuel oil no. 2
Chemical Formula: Unspecified or Variable
CAS Number: 68476-30-2
Synonyms: #2 home heating oil; API no. 2 fuel oil; diesel oil; gas oil; home heating oil no. 2; number 2 burner fuel; number 2 fuel oil
Derivation: Residue from distillation (straight run or cracked) of crude oil.
General Use: Used as a fuel in atomizing burners for domestic and industrial heating, in engines of heavy units (ships, trucks, trains), as a source of synthesis gas, in drilling muds, and for mosquito control (coats breeding waters).
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Fuel oil no. 2, ca 100% vol (complex mixture (< 95%) of paraffinic, olefinic, naphthenic, and aromatic hydrocarbons)
Trace Impurities: water and sediment (< 0.05% vol), carbon residue (< 0.35%), ash (< 0.01% wt), sulfur (< 0.7% wt) and benzene (< 100 ppm).

OSHA PEL
As petroleum distillates
8-hr TWA: 500 ppm (2000 mg/m^3)

ACGIH TLV
As diesel fuel
Notice of impending change (1997):
TWA: 100 mg/m^3, *Skin*

NIOSH REL
As petroleum distillates
10-hr TWA: 350 mg/m^3
Ceiling (15 min): 1800 mg/m^3

IDLH Level
As petroleum distillates
1,100 ppm

DFG (Germany) MAK
None established

Section 3 - Hazards Identification

ANSI Signal Word: Warning!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Fuel oil no. 2 is an amber to brown, slighty viscous liquid with a petroleum odor. It can be irritating to the skin and respiratory tract. This low viscosity fuel oil presents a significant aspiration hazard following ingestion, which can result in chemical pneumonitis and respiratory failure. Also Causes: vomiting, diarrhea, central nervous system (CNS) depression, increased rate of respiration, rapid heart beat, and cyanosis (blue coloration of the skin caused by oxygen deficiency). Fuel oil no. 2 can be an environmental hazard if spilled. This flammable liquid is a moderate fire hazard. When heated to decomposition, it will emit acrid smoke and irritating fumes.

Wilson Risk Scale	
R	1
I	2
S	2
K	2

HMIS	
H	1*
F	2
R	0
PPE†	

*Chronic effects
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion
Target Organs: Skin, CNS, cardiovascular system (CVS), respiratory system, mucous membranes
Acute Effects
Inhalation: Respiratory tract irritation, headache, dizziness, euphoria, nausea, increased respiration rate, tachycardia (excessively rapid heart beat), cyanosis, stupor, convulsions, and unconsciousness can result from inhalation of fuel oil no. 2 mist.
Eye: Contact may result in irritation.
Skin: Contact may cause irritation.
Ingestion: Gastrointestinal irritation, vomiting, diarrhea, and in severe cases, CNS depression, progressing to coma and death, can result. Since intestinal absorption of longer chain hydrocarbons is minimal, aspiration into lungs following ingestion is a more significant exposure route; it may result in transient CNS depression, hemorrhaging and pulmonary edema, progressing to renal (kidney) involvement, chemical pneumonitis, and respiratory failure.
Carcinogenicity: IARC lists distillate (light) fuel oils as Group 3 (not classifiable as to carcinogenicity to humans). ACGIH lists a notice of impending change for diesel fuels as TLV-A3 (Animal carcinogen). NTP and OSHA do not list fuel oil no. 2 as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: None reported.

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Chronic Effects: Prolonged and repeated skin contact can cause dermatitis, irritate the hair follicles and may block the (oil) sebaceous glands, producing a rash of acne pimples, usually on the arms and legs. Repeated exposures producing CNS effects may lead to permanent nervous system damage.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain and/or irritation develop.

Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water followed by washing the exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. *Do not* induce vomiting unless the poison control center advises otherwise.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Gastric lavage for treatment of ingestion is contraindicated due to aspiration hazard. Administer charcoal slurry cathartic (30 g/240 mL diluent). In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases and obtain chest x-ray.

Section 5 - Fire-Fighting Measures

Flash Point: 136 °F (57.78 °C)

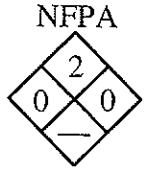
Flash Point Method: CC

Autoignition Temperature: 494 °F (257 °C)

LEL: 0.6% v/v

UEL: 7.5% v/v

NFPA



Flammability Classification: OSHA Class II Combustible Liquid.

Extinguishing Media: Use dry chemical, carbon dioxide, foam, water fog or spray. Water may be ineffective in putting out a fire involving fuel oil no. 2, and a solid water stream may spread the flames; however, a water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.

Unusual Fire or Explosion Hazards: Can form explosive mixtures in air. In still air, the heavier-than-air vapors of fuel oil no. 2 may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire.

Hazardous Combustion Products: Heating fuel oil no. 2 to decomposition can produce thick acrid smoke and irritating fumes.

Fire-Fighting Instructions: If tank, rail car or tank truck is involved in fire isolate for 1/2 mile (800 m). *Do not* release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). All equipment used when handling the product must be grounded. *Do not* touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Isolate area for at least 80-160 ft (25-50 m) in all directions. Water spray or fire fighting foam may suppress vapor, but may not prevent ignition in closed spaces. Use natural barriers or oil spill control booms to confine oil slicks on surface water.

Small Spills: Absorb fuel oil no. 2 with vermiculite, earth, sand or similar material.

Large Spills

Containment: For large spills, consider downwind evacuation of at least 1000 ft (300 m). Dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Cleanup: Ground all equipment. Spills can be absorbed with materials such as peat, activated carbon, polyurethane foam, or straw. Sinking agents, gelling agents, dispersants, and mechanical systems can also be used to treat oil spills. Use clean non-sparking tools to collect absorbed material.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations as low as possible. Wear protective gloves (or use barrier cream) and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers.

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Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (See Sec. 10). Periodically inspect stored materials. Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.106) for a Class II Combustible Liquid.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Enclose operations and/or provide local exhaust ventilation at the site of chemical release designed for flammable vapors/mists. Where possible, transfer fuel oil no. 2 from drums or other storage containers to process containers. Minimize sources of ignition in surrounding low-lying areas.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), use an SCBA.
Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets of Viton™ or nitrile rubber, if possible, or alternatively, polyvinyl chloride, chlorinated polyethylene or neoprene to prevent skin contact. Butyl rubber may degrade after contact and is not recommended. Wear protective eyeglasses per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid

Appearance and Odor: Amber to brown, slightly viscous; petroleum odor

Odor Threshold: 0.082 ppm

Formula Weight: N/A

Specific Gravity (H_2O=1, at 4 °C): 0.8654 at 59 °F (15 °C)

Water Solubility: Slightly soluble

Boiling Point: 450 °F (232 °C)

Freezing Point: -50.8 °F (-46 °C)

Viscosity: 268 centistoke at 100 °F (37.8 °C)

Surface Tension: 25 dynes/cm, estimated

Henry's Law Constant (H): 29 to 68 atm-m^3/mole at 77 °F (25 °C), estimated

Octanol/Water Partition Coefficient: log K_{ow} = 8.2 to 9.7

Soil Sorption Coefficient (K_{oc}): $1x10^4$, estimated

Section 10 - Stability and Reactivity

Stability: Fuel oil no. 2 is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include strong oxidizing agents.

Conditions to Avoid: Heat and ignition sources.

Hazardous Decomposition Products: Thermal oxidative decomposition of fuel oil no. 2 can produce various hydrocarbons, hydrocarbon derivatives, partial oxidation products (carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2)).

Section 11- Toxicological Information

Toxicity Data:*

Skin Effects:
Rabbit, skin, standard Draize test: 500 mg/24 hr, resulted in moderate irritation.

Acute Dermal Effects:
Rabbit, skin, LD: > 5 g/kg

Acute Oral Effects:
Rat, oral, LD_{50}: 12 g/kg

Eye Effects:
Rabbit, eye, standard Draize test: 100 mg/30 seconds, resulted in mild irritation.

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Section 11- Toxicological Information - *continued*

Toxicity Data:*

Tumorigenicity:
Mouse, skin: 243 g/kg/97 weeks, administered intermittently, caused skin and appendage tumors (carcinogenic by RTECS criteria).

Multiple Dose Toxicity Data:
Rabbit, skin: 100 mL/kg/12 days, continuously, caused irritative dermatitis, weight loss or decreased weight gain, and death.

* See NIOSH, *RTECS* (LS8930000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Juvenile American shad, TLm/24 hr: 200 ppm; bluegill, LC_{50} = 95 mg/L/96 hr; carp, LC_{50} = 8.2 mg/L/24 hr; pumpkin seed, LC_{50} = 1.9 mg/L/24 hr. Through its coating action, this material can pose a hazard to aquatic biota including water birds, plankton, algae and fish.

Environmental Fate: Based on a calculated BCF ($1.02x10^4$ to $1.4x10^4$), bioconcentration could be an important environmental fate process; however, it may be limited for the chief components of fuel oil no. 2 due to metabolism.

Environmental Degradation: It may biodegrade in water and soil, or volatilize from water (half-life of 4.4- 4.8 hours from a model river) and moist soil surfaces, but adsorption may attenuate the rate of these processes. In the atmosphere, fuel oil no. 2 will rapidly degrade by reaction with photochemically produced hydroxyl radicals (estimated half-life 1 day or less).

Soil Adsorption/Mobility: A high Koc indicates significant sorption and low mobility in the soil column.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Material may be sprayed into an incinerator. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Fuel oil (1, 2, 4, 5 or 6)
Shipping Symbols: D
Hazard Class: 3
ID No.: NA1993
Packing Group: III
Label: Flammable Liquid
Special Provisions (172.102): B1

Packaging Authorizations
a) **Exceptions:** 173.150
b) **Non-bulk Packaging:** 173.203
c) **Bulk Packaging:** 173.242

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 60 L
b) **Cargo Aircraft Only:** 220 L

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** –

Section 15 - Regulatory Information

EPA Regulations:
Classified as a RCRA Hazardous Waste (40 CFR 261.21), Characteristic of Ignitability
RCRA Hazardous Waste Number: D001
Listed as a CERCLA Hazardous Substance (40 CFR 302.4), Unlisted Hazardous Waste, Characteristic of Ignitability, per RCRA Section 3001
CERCLA Final Reportable Quantity (RQ), 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, as petroleum distillates)

Section 16 - Other Information

References: 1, 73, 103, 136, 190, 223, 230, 231

Prepared By..... HM Spliethoff, MS
Industrial Hygiene Review..... PA Roy, MPH, CIH
Medical Review..... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection

Diesel Fuel Oil No. 2-D MSDS No. 470

Date of Preparation: 10/81 Revision: B, 3/98

Section 1 - Chemical Product and Company Identification 51

Product/Chemical Name: Diesel fuel oil no. 2-D
Chemical Formula: Unspecified or variable
CAS Number: 68334-30-5
Synonyms: automotive diesel oil; diesel fuel; diesel oil (medium); diesel oil no. 2; diesel oil (petroleum); diesel oils; diesel test fuel; fuels, diesel; no. 2 diesel oil; olej napeldowy III (Polish)
Derivation: Fuel oil may be a distilled fraction of petroleum, a residuum from refinery operations, a crude petroleum or a blend of two or more of these.
General Use: This medium viscosity residual fuel oil has both light and heavy grades, and is used in furnaces and boilers of utility and industrial power plants, ships, locomotives, and metallurgical operations.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Diesel fuel oil no. 2-D, ca 100% vol; diesel fuels consist primarily of aliphatic (64% vol), aromatic (35% vol), and olefinic (1-2% vol) hydrocarbons.
Trace Impurities: May contain sulfur (< 0.5), benzene (<100 ppm), and additives such as sulfurized esters.

OSHA PEL
As petroleum distillates
8-hr TWA: 500 ppm (2000 mg/m^3)

ACGIH TLV
As diesel fuel
Notice of impending change (1997):
TWA: 100 mg/m^3, *Skin*

NIOSH REL
As petroleum distillates
10-hr TWA: 350 mg/m^3
Ceiling (15 min): 1800 mg/m^3

IDLH Level
As petroleum distillates
1,100 ppm

DFG (Germany) MAK
None established

Section 3 - Hazards Identification

ANSI Signal Word: Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Diesel fuel oil no. 2-D is a brown, slightly viscous liquid with a kerosene-like odor. It is irritating to the skin and respiratory tract. Inhalation of mist or vapor may result in headache, nausea, vomiting, diarrhea, central nervous system (CNS) depression, tachycardia (rapid heart beat), cyanosis (blue coloration of skin due to oxygen deficiency), pulmonary edema (fluid in the lungs), and liver or kidney injury. Diesel fuel oil no. 2-D is an environmental hazard when spilled. When exposed to heat or flame, this flammable liquid is a fire hazard. When heated to decomposition, diesel fuel oil no. 2-D will emit acrid smoke and irritating vapors.

Wilson Risk Scale	
R	1
I	2
S	2*
K	2

*Skin absorption

HMIS	
H	1*
F	2
R	0
PPE†	

*Chronic effects
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact/absorption
Target Organs: Skin, CNS, cardiovascular system (CVS), respiratory system, liver, kidneys
Acute Effects
Inhalation: Euphoria, respiratory irritation, cardiac dysrhythmia, increased respiration rates, cyanosis, pulmonary edema, hemoptysis (spitting up blood from the respiratory tract), respiratory arrest, renal (kidney) and liver injury, and CNS toxicity can result from inhalation of diesel fuel oil no. 2-D mist or vapor.
Eye: Contact may result in irritation.
Skin: Contact may cause irritation, systemic effects (see Inhalation), and block the sebaceous (oil) glands, resulting in a rash of acne-like pimples and spots, usually on the arms and legs.
Ingestion: Gastrointestinal irritation, vomiting, diarrhea, and in severe cases, CNS depression progressing to coma and death and other systemic effects (see Inhalation) can result. Aspiration can result in transient CNS depression or excitement, hypoxia, infection, pneumatocele (abnormal cavities in lungs) formation, and chronic lung dysfunction.
Carcinogenicity: IARC lists occupational exposure in petroleum refining as Group 2A (Probable human carcinogen) and distillate light (diesel) fuels as Group 3 (Not classifiable as to carcinogenicity to humans). ACGIH lists a notice of impending change for diesel fuels as TLV-A3 (Animal carcinogen). NTP and OSHA do not list diesel fuel oil no. 2-D as a carcinogen.

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Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: Prolonged or repeated skin contact causes dermatitis and possible systemic toxicity. Prolonged or repeated inhalation can cause CNS and peripheral nervous system damage.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain and/or irritation develops.

Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water followed by washing the exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Have the *conscious and alert* person drink 1 to 2 glasses of water. Contact a poison control center. Because of aspiration risk, *do not* induce vomiting unless the poison control center advises otherwise.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Gastric lavage is contraindicated due to aspiration risk. Instead, consider administration of charcoal or milk. If ingestion amount is large, gastric emptying in the alert patient can be accomplished through administration of Syrup of Ipecac. Treat overexposure symptomatically and supportively.

Section 5 - Fire-Fighting Measures

Flash Point: 100.4 °F (38 °C)

Flash Point Method: CC

Autoignition Temperature: 351-624 °F (177-329 °C)

LEL: 1.3% v/v

UEL: 75% v/v



Flammability Classification: OSHA Class II Combustible Liquid

Extinguishing Media: Use dry chemical, carbon dioxide, foam, low velocity water fog or spray. Use a smothering technique to extinguish fire. Water may be ineffective in putting out a fire involving diesel fuel oil no. 2-D, and a solid water stream may spread the flames; however, a water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.

Unusual Fire or Explosion Hazards: Vapor or mist can form explosive mixtures in air. In still air, the heavier-than-air vapors of diesel fuel oil no. 2-D from a large source may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire.

Hazardous Combustion Products: Heating diesel fuel oil no. 2-D to decomposition can produce acrid smoke and irritating vapors.

Fire-Fighting Instructions: *Do not* release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Ground all equipment used when handling this product. *Do not* touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A fire fighting foam may be used to suppress vapors. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Use clean non-sparking tools to collect absorbed material.

Small Spills: Absorb diesel fuel oil no. 2-D with vermiculite, earth, sand or similar material.

Large Spills

Containment: For large spills, consider downwind evacuation of at least 1000 ft (300 m). Dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Cleanup: Ground all equipment. Use non-sparking tools. Spills can be absorbed with materials such as peat, activated carbon, polyurethane foam, or straw. Sinking agents, gelling agents, dispersants, and mechanical systems can also be use to treat oil spills.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves (or use barrier cream), and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers.

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Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Periodically inspect stored materials. Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.106) for Class II Combustible Liquid.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Enclose operations and/or provide local exhaust ventilation appropriately designed for flammable mist and vapor at the site of chemical release. Where possible, transfer diesel fuel oil no. 2-D from drums or other storage containers directly to process containers. Minimize sources of ignition in surrounding low-lying areas.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), use an SCBA.
Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets. Wear protective eyeglasses, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Brown, slightly viscous; kerosene-like odor
Odor Threshold: 0.7 ppm
Vapor Pressure: < 0.1 mm Hg at 68 °F (20 °C)
Vapor Density (Air=1): > 6
Formula Weight: N/A

Specific Gravity (H_2O=1, at 4 °C): < 0.86
Water Solubility: Insoluble
Boiling Point: 340-676 °F (171-358 °C)
Freezing Point: -29.2 °F (-34 °C)
Viscosity: 1.9-4.1 centistoke at 104 °F (40 °C)
Surface Tension: 23-32 dynes/cm at 68 °F (20 °C)

Section 10 - Stability and Reactivity

Stability: Diesel fuel oil no. 2-D is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include strong oxidizing agents.

Conditions to Avoid: Exposure to heat and ignition sources.

Hazardous Decomposition Products: Thermal oxidative decomposition of diesel fuel oil no. 2-D can produce low molecular weight hydrocarbons, hydrocarbon derivatives, carbon oxides (CO_x), and sulfur oxides (SO_x).

Section 11- Toxicological Information

Acute Oral Effects:
Rat, oral, LD_{50}: 7500 mg/kg

Acute Dermal Effects:
Rabbit, skin, LD: > 5 mL/kg

Skin Effects:
Rabbit, skin, standard Draize test: 500 µL/24 hr, resulted in severe reaction.

Toxicity Data:*

Other Multiple Dose Toxicity Data:
Rat, inhalation: 2 g/m³/6 hr/3 weeks, intermittently, resulted in changes in blood erythrocyte (RBC) count, and focal fibrosis (pneumonoconiosis) and other changes in the lung, thorax or respiration.
Rat, inhalation: 400 µg/m³/16 hr/2.5 years, intermittently, caused other changes in the blood, and biochemical effects - transaminases.
Rabbit, skin: 80 mL/kg/12 days, continuously, resulted in other changes in the liver, kidney, ureter, and bladder, and death.

* See NIOSH, *RTECS* (HZ1800000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: Juvenile American shad, salt water TLm: 204 mg/L/24 hr; mallard duck, LD_{50}=20 mg/kg.

Environmental Fate: Diesel fuel oil no. 2-D will evaporate from water or soil. In surface water, it may partition from the water column to suspended sediments.

Environmental Degradation: Biodegradation may occur in soil and water.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Diesel fuel
Shipping Symbols: D
Hazard Class: 3
ID No.: NA1993
Packing Group: III
Label: None
Special Provisions (172.102): B1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 60 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: –

Section 15 - Regulatory Information

EPA Regulations:

Classified as RCRA Hazardous Waste (40 CFR 261.21): Characteristic of Ignitability
RCRA Hazardous Waste Number: D001
Listed as a CERCLA Hazardous Substance (40 CFR 302.4), Unlisted Hazardous Waste, Characteristic of Ignitability per RCRA Sec. 3001
CERCLA Final Reportable Quantity (RQ): 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A, as petroleum distillates)

Section 16 - Other Information

References: 73, 103, 136, 190, 209, 222, 230, 231

Prepared By..... HM Spliethoff, MS
Industrial Hygiene Review..... PA Roy, MPH, CIH
Medical Review..... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection

Thallium **MSDS No. 80**

Date of Preparation: 12/80 Revision: B, 3/98

Section 1 - Chemical Product and Company Identification 51

Product/Chemical Name: Thallium
Chemical Formula: Tl
CAS Number: 7440-28-0
Synonyms: elemental thallium; Ramor; thallium metal
Derivation: Exists in flue dusts from lead and zinc smelters and pyrite burners. Obtained from thallium compounds by electrolysis, precipitation, or reduction.
General Use: Alloyed with mercury for switches and closures which operate at subzero temperatures; used in the manufacture of thallium salts; of mercury alloys and low-melting glasses; used in cardiac imaging; electrodes in dissolved oxygen analyzers; in photoelectric cells, lamps, and electronics; in scintillation counters; as a catalyst in organic synthesis; in magnesium seawater batteries; as a rodenticide (former use).
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Thallium, ca 99.9 - 100%
Trace Impurities (technical grade): lead, zinc, nickel, cadmium, indium, germanium, selenium, tellurium, arsenic

OSHA PEL
Thallium, elemental, and soluble compounds, as Tl
8-hr TWA: 0.1 mg/m^3, *Skin*

ACGIH TLV
Thallium, elemental, and soluble compounds, as Tl
TWA: 0.1 mg/m^3, *Skin*
Excursion Limit: Provided the TLV-TWA is not exceeded, exposure may exceed 0.3 mg/m^3 for no more than 30 min/day, never exceed 0.5 mg/m^3.

NIOSH REL
Thallium, elemental, and soluble compounds, as Tl
10-hr TWA: 0.1 mg/m^3, *Skin*

IDLH Level
15 mg/m^3

DFG (Germany) MAK
Thallium, elemental, and soluble compounds, as Tl
TWA: 0.1 mg/m^3
Category III: Substances with systemic effects, onset of effect >2 hr half-life > shift length (strongly cumulative).
Danger of cutaneous absorption

Peak Exposure Limit:
1.0 mg/m^3, 30 min, average value, frequency per shift: 1

Section 3 - Hazards Identification

ANSI Signal Word: Danger!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Thallium is a bluish-white, odorless soft metal or powder. It is toxic by ingestion and may be absorbed in toxic amounts through skin contact or inhalation. Exposure also causes: skin sensitization, central nervous system (CNS) and gastrointestinal (GI) tract effects, kidney damage, and death. Exposure is cumulative. Thallium dust is flammable.

Wilson Risk Scale
R 2*
I 4
S 3*
K 2
*Powder

HMIS
H 3*
F 2†
R 1
PPE‡
*Chronic effects
†Powder
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact
Target Organs: Central nervous system (CNS), peripheral nerves, cardiovascular system (CVS), gastrointestinal (GI) tract, hair, eyes, respiratory system, liver, kidneys

Acute Effects

Inhalation: Irritation and systemic effects including thallium poisoning. Symptoms of thallium poisoning are often delayed 12 to 24 hours and reach a maximum in the second and third week after exposure. Symptoms include severe sudden abdominal pain, nausea, vomiting, diarrhea, headache, chest pain or tightness, excessive salivation, bloody vomit and stools, sensory nerve disorders, painful tingling in extremities, leg pains, insomnia, hypertension (high blood pressure), tachycardia (rapid heart beat), respiratory failure, decreased visual clarity, impaired color vision, weakness, depression, hair loss, green color to urine, kidney damage, and, in severe cases, tremors, delirium, hallucinations, convulsions, paralysis, coma and death, sometimes within 1 to 2 days. Thallium (metal) is not as toxic as some thallium salts.

Eye: Irritation; may cause vision loss.

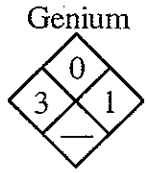
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Skin: Irritation, acne, hair loss, impaired nail growth ("Mee's lines"); may be absorbed, causing systemic effects.
Ingestion: Sweating, nerve or nerve sheath structural changes, eye muscle changes; may cause systemic effects (see Inhalation).
Carcinogenicity: IARC, NTP, and OSHA do not list thallium as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Disorders of the CNS, GI tract, kidneys, liver, and eyes may be worsened by exposure to thallium.
Based on animal studies, thallium may cross the placenta to affect an unborn child.
Chronic Effects: Thallium is a cumulative poison. Chronic effects include systemic effects list under Acute Effects, above, but may also include poor appetite, mood changes, irritability, metallic taste in the mouth, pain in extremities (polyneuritis), alopecia (hair loss), loss of vision, tremor or abnormal muscle jerking, nail changes, dry scaly skin, heart, kidney, and endocrine damage. Permanent brain damage is common.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist if pain, irritation, swelling, or photophobia persist.
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Monitor for systemic effects.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Seek medical attention.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: If over exposure is suspected, monitor cardiac, renal and hepatic function; medical observation for several days is suggested. The most reliable urine test for thallium is a 24-hour urine quantitative assay. Diethylthiocarbamate has been reported to result in dangerous redistribution of thallium to the CNS and is contraindicated.

Section 5 - Fire-Fighting Measures



Flash Point: Not applicable, probable noncombustible solid
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.
Flammability Classification: Probable noncombustible solid
Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2) or water spray. For large fires, use water spray, fog, or regular foam. Fire involving tanks or car/trailer loads: fight fire from maximum distance or use unmanned hose holders or monitor nozzles. *Do not* get water inside containers. Cool containers with flooding quantities of water until well after fire is out.
Unusual Fire or Explosion Hazards: Thallium dust is flammable when exposed to heat or flame. Reacts violently with fluorine.
Hazardous Combustion Products: Toxic fumes of thallium.
Fire-Fighting Instructions: *Do not* release runoff from fire control methods to sewers or waterways. *Do not* scatter thallium.
Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Thoroughly decontaminate equipment after use.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources. Isolate and ventilate area, deny entry, stay upwind. Tag container as defective and return to supplier. Use spark-proof tools and explosion proof equipment. Cleanup personnel should protect against exposure.
Small Spills: *Do not* sweep! Carefully scoop up or vacuum (with a HEPA filter). Absorb liquid spill with an inert, noncombustible absorbent such as sand or vermiculite. Collect in sealed containers for disposal.
Large Spills
Containment: For large spills, dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.
Cleanup: If possible, recover for reuse or recycling.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

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Section 7 - Handling and Storage

Handling Precautions: Avoid any exposure to thallium. To avoid dust inhalation, use only with exhaust ventilation sufficient to reduce airborne concentrations to nonhazardous levels (see Sec. 2). Wear personal protective clothing and equipment to prevent contact with skin and eyes, or dust inhalation (see Sec. 8). Remove contaminated clothing and equipment immediately for proper decontamination. Practice good personal hygiene procedures to prevent inadvertently ingesting this material. Wash any areas which might have come in contact with thallium at the end of the work shift. *Do not* attempt to handle broken containers without proper protective equipment. Whenever possible, transfer thallium directly form storage containers to process containers.

Storage Requirements: Store in tightly closed containers in a cool, well-ventilated area away from heat, ignition sources, incompatibles, and food and foodstuffs.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose operations and exhaust ventilate to avoid dust dispersion into the work area. To prevent static sparks, electrically ground and bond all containers and equipment.

Ventilation: Provide local exhaust ventilation systems equipped with appropriate dust collectors or scrubbers to maintain airborne concentrations below OSHA PEL (see Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Educate workers about the health and safety hazards associated with this material. Train in work practices and PPE which minimize exposure. Consider preplacement and periodic medical exams with emphasis on the eyes, nervous and respiratory systems, liver, kidneys, gastrointestinal tract, and hair. Monitor workplace exposures.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Exposure Range: >0.1 to 1 mg/m^3: air purifying, negative pressure, half mask; >1 to 10 mg/m^3: air purifying, negative pressure, full face; >10 to <15 mg/m^3: supplied air, constant flow/pressure demand, full face; 15 to unlimited mg/m^3: SCBA, pressure demand, full face; cartridge color: dust/mist filter (use P100 or consult supervisor for appropriate dust/mist filter). Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent any skin contact. Wear protective eyeglasses or chemical safety goggles and face shield, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice disciplined personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Bluish white powder; odorless
Vapor Pressure: 1 mm Hg at 1517 °F (825 °C)
Formula Weight: 204.38
Density: 11.85 g/cm^3
pH: Moderately strong base
Water Solubility: Insoluble
Other Solubilities: Slightly soluble in hydrochloric acid, 100 parts nitric acid; soluble in sulfuric acid.
Boiling Point: 2655 °F (1457 °C)
Melting Point: 578.3 °F (303.5 °C)
Ionization Potential (eV): 6.10829

Section 10 - Stability and Reactivity

Stability: Thallium is stable at room temperature in closed containers under normal storage and handling conditions. Exposure to air will result in surface oxidation.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include strong acids and strong oxidizing agents. Reacts violently with fluourine (F_2). Reacts with steam or moist air to produce toxic thallium hydroxide (TlOH), with air to produce thallium (I) oxide (Tl_2O).

Conditions to Avoid: Avoid contact with chemical incompatibles, heat, and sources of ignition.

Hazardous Decomposition Products: Thermal oxidative decomposition of thallium can produce thallium fumes.

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Section 11- Toxicological Information

Toxicity Data:*

Acute Oral Effects:
Man, oral, TD_{Lo}: 5714 µg/kg produced toxic effects: peripheral nerve and sensation - structural change in nerve or sheath; sense organs and special senses - change in extra-ocular muscles; skin and appendages - hair.

Acute Effects:
Man, unreported exposure route, LD_{Lo}: 4412 mg/kg

* See NIOSH, *RTECS* (XG3425000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Freshwater: Atlantic salmon, LD_{50}: 0.03 ppm; *daphnia*, 72 hr threshold: 2-4 ppm; *gammarus*, 72 hr threshold: 4 ppm; perch, 72 hr threshold: 60 ppm. Saltwater: brown shrimp, 96 hr LC_{50}: 10 ppm.
Environmental Fate: May persist indefinitely as cation. Thallium bioaccumulates.

Section 13 - Disposal Considerations

Disposal: If possible, recover for reuse or recycling. Contact your supplier or a licensed contractor for detailed recommendations for disposal. Follow applicable Federal, state, and local regulations.
Container Cleaning and Disposal: Handle empty containers carefully as hazardous residues may still remain. Triple rinse containers and dispose of wash wastewater appropriately.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Thallium compounds, n.o.s.
Shipping Symbols: –
Hazard Class: 6.1
ID No.: UN1707
Packing Group: II
Label: POISON
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: None
b) Non-bulk Packaging: 173.212
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 25 kg
b) Cargo Aircraft Only: 100 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: –

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA, Sec. 307(a)
CERCLA Final Reportable Quantity (RQ), 1000 lb (454 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

Section 16 - Other Information

References: 1, 73, 99, 103, 124, 136, 149, 176, 190, 209, 216, 222, 223, 224, 227, 230

Prepared By..... S Fleming, BS/HM Spliethoff, MS
Industrial Hygiene Review..... PA Roy MPH, CIH
Medical Review..... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection

Mercury **MSDS No. 26**

Date of Preparation: 1/77 Revision: D, 6/94

Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Mercury
Chemical Formula: Hg
CAS No.: 7439-97-6
Synonyms: colloidal mercury, hydrargyrum, liquid silver, Quicksilver
Derivation: Obtained by roasting cinnabar (mercury sulfide) and purified by distillation, or as a by-product of gold mining.
General Use: Used in agricultural poisons, anti-fouling paint, dental amalgams, mining amalgamation (to remove gold and other metals from ore), thermometers, barometers, dry cell batteries, chlorine and caustic soda production, electrical apparatus, and as a neutron absorber in nuclear power plants.
Vendors: Consult the latest *Chemical Week Buyers' Guide*. (73)

Section 2 - Composition / Information on Ingredients

Mercury, ca 100 %wt

OSHA PEL
Ceiling: 0.1mg/m^3 (vapor and inorganic Hg)
8-hr TWA: 0.05 mg/m^3 (vapor), skin; (Vacated 1989 Final Rule Limit)

ACGIH TLVs
TWA: 0.025 mg/m^3 (inorganic compounds), skin

NIOSH REL
10-hr TWA: 0.05 mg/m^3 (vapor), skin

DFG (Germany) MAK
TWA: 0.01 ppm (0.1 mg/m^3)
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:
0.1 ppm (1 mg/m^3), 30 min. average value, 1/shift

IDLH Level
28 mg/m^3

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Mercury exists as a heavy, odorless, silver-white liquid metal. It is highly toxic by both acute and chronic exposure. Exposure can cause corrosion of the eyes, skin, and respiratory tract and may result in irreversible nervous system damage. It readily forms amalgamations with most metals except iron.

Wilson Risk Scale	
R	1
I	4
S	2*
K	1

*Skin absorption

HMIS	
H	4*
F	0
R	0

*Chronic effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, eye and skin contact/absorption.
Target Organs: Central nervous system, eyes, skin, respiratory system, liver, kidneys.
Acute Effects

Inhalation: Exposure to high vapor concentrations can cause severe respiratory damage. Other symptoms include wakefulness, muscle weakness, anorexia, headache, ringing in the ear, headache, diarrhea, liver changes, fever, gingivitis, chest pain, difficulty breathing, cough, inflammation of the mouth (stomatitis), salivation, bronchitis, and pneumonitis. Acrodynia (pink or Swifts disease), characterized by redness and peeling of the skin on the toes and fingers, was commonly seen in children in the 1950s and is still *infrequently* seen in workers.

Eye: Irritation and corrosion.

Skin: Skin can become severely irritated if allowed to remain in contact with mercury. Skin absorption will occur at 2.2% of the rate of absorption through the lungs.

Ingestion: Mercury generally passes through the digestive tract uneventfully. However, large amounts may get caught up in the intestine and require surgical removal. If an abscess or other perforation is present along the digestive tract, absorption into the blood stream with subsequent mercury poisoning is possible.

Carcinogenicity: IARC, NTP, and OSHA do not list mercury as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.
Chronic Effects: Chronic exposure appears more common than acute and is primarily associated with central nervous system damage which can be permanent (ex. paresthesia of the hands, lips, feet). Early signs of toxicity include weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. If exposure levels are high, characteristic tremors of the fingers, eyelids, and lips occur with progression to generalized tremors of the entire body. Psychic disorders are noticeable and characterized by behavior and personality changes, increased excitability, memory loss, insomnia, and depression. In severe cases, delirium and

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hallucinations may occur. Kidney damage is observed with oliguria (decreased urine output) progressing to anuria (urine cessation) and may require dialysis. The cornea and lens of the eyes may take on a brownish discoloration and the extraocular muscles may be damaged. This syndrome has been termed *Asthenic-Vegetative Syndrome* or *Micromercurialism.* Chronic symptoms occur increasingly with exposures to 0.1 mg/m^3 or higher. *Mutation:* Aneuploidy and other chromosomal aberrations have been observed in the lymphocytes from whole blood cultures in workers exposed to mercury. *Reproductive:* Mercury has been detected in stillborn babies of women treated with mercury for syphilis. In a study of six men acutely exposed (occupationally) to mercury levels as high as 44 mg/m^3, all suffered impaired sexual function. Repeated skin contact may cause allergic dermatitis in some individuals.

NOTE: Spilled mercury will release sufficient vapor over time to produce chronic poisoning.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

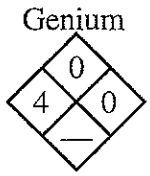
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water and then wash exposed area with soap. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. In general, mercury will pass through the digestive tract uneventfully.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI: *blood* (15 µg/L), *urine*: (35 µg/g creatinine). Extremely high urine levels of 0.5 to 0.85 mg Hg/L are indicative of polyneuropathy. 0.4 to 22 µg/L is reported to be the human lethal blood level. Obtain urinalysis including at a minimum: albumin, glucose, and a microscopic examination of centrifuged sediment. Use BAL or 2, 3-dimercaptosuccinic acid as chelators. *Do not* use calcium sodium EDTA because of nephrotoxicity. An electromyograph may determine extent of nerve dysfunction. It has been noted that exposure to mercury may predispose persons to development of carpal tunnel syndrome.

Section 5 - Fire-Fighting Measures



Flash Point: Nonflammable

Autoignition Temperature: Nonflammable

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use agents suitable for surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Toxic mercury vapor and mercuric oxide.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Keep a mercury spill kit readily available in areas where mercury is used. Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind.

Small and Large Spills: Follow instructions on mercury spill kit. Most kits come with an aspiration-driven vacuum trap with a mercury "sweeper" (copper or copper-plated brush). Wash spill area with a dilute calcium sulfide or nitric acid solution. If spill cannot be taken up readily, dust the top of the spill with flowers of sulfur or preferably, calcium polysulfide. This will produce a surface coating of mercury sulfide which will reduce mercury vapor dispersion into the air.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use appropriate PPE when working with mercury. *Do not* use on porous work surfaces (wood, unsealed concrete, etc.) to prevent spills from lodging in cracks.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and incompatibles (Sec. 10). Store on non-porous floors and wash them regularly with a dilute calcium sulfide solution. Because mercury will form amalgamations with most metals except iron, metal shelves should be painted with a sufficiently thick coating to prevent this from happening.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Wherever possible, enclose processes to prevent mercury vapor dispersion into work area.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)

Administrative Controls: Consider pre-placement and periodic medical exams of exposed workers with emphasis on the skin, eyes, central nervous system, liver, and kidneys.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For $\leq$ 0.5 mg/m^3, use any chemical cartridge

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respirator with cartridges providing protection against mercury and equipped with an ESLI (end of service life indicator), any SCBA, or any SAR (supplied-air respirator). For ≤ 1.25 mg/m^3, use any SAR operated in continuous-flow mode, any PAPR (powered, air-purifying respirator) with an ESLI. For ≤ 2.5 mg/m^3, use any SCBA or SAR with a full facepiece, any SAR with a tight-fitting facepiece and operated in continuous-flow mode, or any chemical cartridge respirator with a full facepiece, chemical cartridges providing protection against mercury, and equipped with an ESLI. For ≤28 mg/m^3, use any SAR operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with full facepiece and operated in pressure-demand or other positive pressure mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, nitrile rubber, fluorocarbon rubber, neoprene rubber, polyvinyl chloride, chlorinated polyethylene, or polycarbonate to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid metal
Appearance and Odor: Silvery-white, odorless
Vapor Pressure: 0.0018 mm Hg at 77 °F (25 °C)
Formula Weight: 200.59
Density (H_2O=1): 13.534 g/cm^3 at 77 °F (25 °C)
Boiling Point: 674.09 °F (356.72 °C)
Freezing Point: -37.97 °F (-38.87 °C)
Viscosity: 15.5 mP at 77 °F (25 °C)
Electrical Resistivity: 95.76 µohm at 68 °F (20 °C)

Water Solubility: 0.28 µmol/L at 77 °F (25 °C)
Other Solubilities: Soluble in boiling sulfuric acid, nitric acid (reacts); slightly in lipids, and 2.7 mg/L in pentane. Insoluble in alcohol, ether, cold sulfuric acid, hydrogen bromide, and hydrogen iodide.
Surface Tension: 484 dyne/cm at 77 °F (25 °C)
Critical Temperature: 2664 °F (1462 °C)
Critical Pressure: 1587 atm

Section 10 - Stability and Reactivity

Stability: Mercury does not tarnish at ordinary temperatures but when heated to near its boiling point, it slowly oxidizes to mercuric oxide.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Mercury forms alloys (amalgamates) with most metals except iron. It is incompatible with oxidizers such as bromine, 3-bromopropyne, methylsilane + oxygen, chlorine, chlorine dioxide, nitric acid, or peroxyformic acid; tetracarbonyl nickel + oxygen, alkynes + silver perchlorate, ethylene oxide, acetylenic compounds (explosive), ammonia (explosive), boron phosphodiiodide, methyl azide, nitromethane, and ground sodium carbide.

Conditions to Avoid: Exposure to high temperatures, metal surfaces or incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of mercury can produce mercuric oxide.

Section 11- Toxicological Information

Toxicity Data:*

Reproductive:
Rat, inhalation: 890 ng/m^3/24 hr for 16 weeks prior to mating had an effect on spermatogenesis.

Acute Dermal Toxicity:
Man, skin, TD_{Lo}: 129 mg/kg for 5 continuous hours caused ringing in the ears, headache, and allergic dermatitis.

Acute Oral Toxicity:
Man, oral, TD_{Lo}: 43 mg/kg caused tremor and jaundice or other liver changes.

Acute Inhalation Effects:
Woman, inhalation, TC_{Lo}: 150 µg/m^3/46 days caused anorexia, diarrhea, and wakefulness.
Man, inhalation, TC_{Lo}: 44300 µg/m^3/8 hr caused muscle weakness, liver changes, and increased body temperature.

Chronic Effects:
Rat, inhalation: 1 mg/m^3/ 24 hr for 5 continuous weeks caused proteinuria.

* See NIOSH, *RTECS* (OV4550000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: Catfish, LC_{50} = 0.35 mg/L/96 hr; mollusk (*Modiolus carvalhoi*), LC_{50} = 0.19 ppm/96 hr: tadpole (*Rana hexadactyla*), LC_{50} = 0.051 ppm/96 hr. Mercury is transformed to methyl mercury by bacteria in the environment and undergoes bioaccumulation readily. BCF for freshwater fish = 63,000; for saltwater fish = 10,000; and for marine and freshwater invertebrates = 100,000.

Environmental Degradation: Mercury is expected to volatilize rapidly when deposited on soil surfaces. Once in the air, it can be transported long distances before being redeposited on soil or in water. In water, mercury appears to bind to particulates where it eventually becomes deposited on the bed sediment. In general, mercury entering the environment can be deposited and revolatilized several times.

Section 13 - Disposal Considerations

Disposal: Incineration is *not* an appropriate disposal method. Wastewater may be treated by addition of chlorine to oxidize the mercury to its ionic state. The water can then be passed through an absorbent (an activated charcoal concentrate with a sulfur coating or peanut shell charcoal) to collect the ionic mercury, followed by distillation to recover the mercury. Sodium borohydride, a reducing agent, can be used to precipitate mercury from waste solutions. Bioremediation, using *Pseudomonas putida*, has also been suggested. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Mercury
Shipping Symbols: A, W
Hazard Class: 8
ID No.: UN2809
Packing Group: III
Label: Corrosive
Special Provisions (172.102): --

Packaging Authorizations
a) Exceptions: 173.164
b) Non-bulk Packaging: 173.164
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 35 kg
b) Cargo Aircraft Only: 35 kg

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40, 97

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U151
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA 311/312 Codes: 1, 2
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 159, 167, 176, 187, 189

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... RE Langford, PhD, CIH
Medical Review ..... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection

Asbestos **MSDS No. 15**

Date of Preparation: 11/90 Revision: A, 9/97

Section 1 - Chemical Product and Company Identification 50

Product/Chemical Name: Asbestos

Chemical Formula: actinolite, $Ca_2(Fe^{2+}, Mg)_5Si_8O_{22}(OH)_2$; amosite, $(Fe^{2+},Mg)_7Si_8O_{22}(OH)_2$; anthophyllite, $(Mg, Fe^{2+})_7Si_8O_{22}(OH)_2$; chrysotile, $Mg_3Si_2O_5(OH)_4$; crocidolite, $Na_2(Fe^{2+}, Mg)_3Fe^{3+}{}_2Si_8O_{22}(OH)_2$; tremolite, $Ca_2Mg_5Si_8O_{22}(OH)_2$;

CAS Number: CAS No. 1332-21-4, asbestos; CAS No. 12172-73-5, amosite, brown asbestos; CAS No. 12001-29-5, chrysotile, white asbestos; CAS No. 12001-28-4, crocidolite, blue asbestos; CAS No. 17068-78-9, anthophyllite; CAS No. 13768-00-8, actinolite

Synonyms: actinolite; ascarite; amosite; anthophyllite; chrysotile; crocidolite; earth flax; mountain cork; stone flax; tremolite

Derivation: Asbestos is a generic term applied to many naturally occurring, hydrated silicates (minerals) found in rock which separate into flexible fibers when crushed or processed. Commercially important forms are amosite, anthophyllite (mined and used only in Finland), chrysotile, and crocidolite. Other types include tremolite and actinolite.

General Use: Chrysotile was most widely used in US industry. Since asbestos is insensitive to chemical attack and incombustible, asbestos has been used in more than 5,000 products including thermal and electrical insulation, roofing, cement pipe and sheet flooring, friction materials, gaskets, coatings, plastics, textiles, and paper products. However, due to its health hazards, other materials are now replacing it wherever possible. Under TSCA, EPA proposed to prohibit or phase out the manufacture and use of asbestos in certain products. EPA issued a final rule banning the manufacture, importation, processing, and distribution of most asbestos-containing products. Between 1950 and 1972 asbestos was used as spray insulation in buildings, but OSHA now prohibits spray application of actinolite, anthophyllite, asbestos, or tremolite (29 CFR 1910.1001).

Section 2 - Composition / Information on Ingredients

Asbestos, ca 100 %wt

Trace Impurities: Metals including nickel, cobalt, chromium, manganese, beryllium, cadmium, copper, and thallium; other fibrous materials including tremolite and brucite; and oils and waxes.

OSHA PELs*
8-hr TWA: 0.1 f/cc
30-min STEL: 1 f/cc
Carcinogen - See 29 CFR 1910.1001

NIOSH REL*
10-hr TWA: 0.1 f/cc
Carcinogen - Use 29 CFR 1910.1001

DFG (Germany) MAK
None established

ACGIH TLVs†
Amosite (12172-73-5): TWA: 0.5 f/cc ‡
Chrysotile (12001-29-5): TWA: 2 f/cc
Crocidolite (12001-28-4): TWA: 0.2 f/cc
Asbestos, other forms: TWA: 2 f/cc

IDLH Level
Not determined

* The following limits are applicable for amosite (12172-73-5), chrysotile (12001-29-5), crocidolite (12001-28-4), and asbestos, other forms.
† Notice of Intended Change: 0.1 f/cc
‡ Fibers longer than 5 µm; aspect ratio ≥ 3:1 as determined by the membrane filter method at 400-450X magnification (4-mm objective) phase contrast illumination.

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

White or greenish (chrysotile), blue (crocidolite), or gray-green (amosite) fibrous, odorless solids. Asbestos causes three specific diseases: asbestosis (fibrous lung scarring), lung cancer, and mesothelioma (cancer of the chest lining and abdominal cavities). These diseases typically develop decades (20 to 40 yr) after exposure begins, but may occur sooner. Prevent or minimize asbestos exposure.

Wilson Risk Scale
R 0
I 4
S 1
K 0

HMIS
H 1*
F 0
R 0
PPE†

* Chronic Effects: Cancer Hazard
† Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin and/or eye contact

Target Organs: Respiratory system, eyes; possibly digestive system

Acute Effects

Inhalation: Nose and throat irritation are possible with high exposure.

Eye: Irritation.

Skin: Irritation with exposure to high concentrations.

Ingestion: Gastrointestinal tract irritation is possible.

Carcinogenicity: IARC, NTP, OSHA, ACGIH, NIOSH, EPA, and MAK list asbestos as IARC-1 (carcinogenic to humans), NTP-1 (known to be a carcinogen), OSHA-X (carcinogen defined with no further categorization),

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ACGIH-TLV-A1 (confirmed human carcinogen), EPA-A (human carcinogen), and MAK-A1 (capable of inducing malignant tumors as shown by human experience).

Medical Conditions Aggravated by Long-Term Exposure: Long-term, high-level exposure may aggravate any chronic lung (asthma, emphysema, bronchitis) or heart condition.

Chronic Effects: Asbestos may cause 1) asbestosis, 2) lung cancer, 3) mesothelioma, 4) pleural plaques, and 5) several other forms of cancer. *Asbestosis* is fibrosis (scarring) of lung tissue after many years of high-level occupational exposure. Scarring may be progressive even after exposure ceases. Even though detectable in lungs of a high proportion of adults in industrialized areas, asbestosis does not result from lower level environmental exposure. Its symptoms range from mild shortness of breath and dry cough to severe disabling breathlessness, heart failure, and ultimately death. Lung scarring can be seen on X-ray and alterations in lung function can be detected with spirometry (a medical test). Examination typically detects rales (crackling sounds in lungs). Severe cases may have cyanosis (bluish skin discoloration) and clubbing of fingertips. *Lung cancer* can result from lower exposure levels than asbestosis, but also takes many years to develop. Smokers exposed to asbestos are at 5 to 10X higher risk than exposed nonsmokers. *Mesothelioma* is a very aggressive cancer of the pleura (lining around the lungs) or peritoneum (lining of the abdomen), and develops after decades of (sometimes low level) exposure. Symptoms may include chest and abdominal pain, weight loss, and/or shortness of breath, with death within 2 years of diagnosis. *Pleural plaques* are thickenings, sometimes with calcium deposits, of the lung's lining and may be seen on X-ray. While not associated specifically with health effects, they indicate significant exposure. *Other sites of cancer* include larynx (vocal cords), portions of digestive tract, and possibly the kidney. Asbestos's toxicity depends on fiber type (crocidolite > amosite > chrysotile), size (longer > shorter), shape (long, thin needle-like > curly), and solubility. Health effects depend on dose (exposure concentration and duration), smoking habits, and individual susceptibility.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air. Clean any fibers from nose and mouth. Encourage victim to cough, spit, and blow nose to remove fibers.

Eye Contact: Do not rub. Gently lift eyelids and flush with flooding amounts of water.

Skin Contact: Shower with water and soap. Wet contaminated clothing prior to removal and seal in a plastic bag for disposal as hazardous waste. If rash develops, consult physician.

Ingestion: Induce vomiting *only* if awake and alert. Consult a physician.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Asbestosis diagnosis is based on chest X-ray with an abnormal ILO "B" reading (small irregular opacities), rales, restrictive pattern spirometry, adequate exposure history, and symptoms. Consider pneumovax, annual flu shot, and other supportive treatment as needed. See Sec. 8, Administrative Controls for specific recommendations for medical surveillance.

Special Precautions/Procedures: Emergency personnel should protect against any exposure when aiding victims.

Section 5 - Fire-Fighting Measures

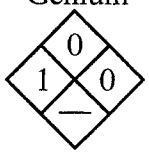
Flash Point: Not applicable (NA); noncombustible solid.

Autoignition Temperature: NA

LEL: NA

UEL: NA

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Extinguishing Media: Use extinguishing media appropriate for surrounding fire. Wet asbestos fibers with water spray to prevent dust generation. *Do not* scatter spilled asbestos with high-pressure water streams.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: None; noncombustible solid.

Fire-Fighting Instructions: Isolate hazard area and deny entry. Avoid asbestos dust generation and inhalation; it may have damaging effects on the lungs. *Do not* release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because there may be airborne asbestos fibers, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel and evacuate all unnecessary personnel. Cleanup personnel should protect against dust inhalation and skin or eye contact. Avoid dust generation, blowing, dry brushing, and dry mopping. Provide HEPA-filtered (high-efficiency particulate air) portable ventilation systems. Use wet cleaning methods or approved HEPA vacuum cleaning system to pick up spills. The techniques used must collect particulate without dispersing dust into air. Place waste in *properly labeled* dust-tight containers or sealed, heavy-gauge, impervious plastic bags for disposal.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid any exposure to asbestos. Work with asbestos only in a sufficient wet state to prevent emission of airborne fibers. Practice good personal hygiene and housekeeping procedures. Use only with ventilation sufficient to reduce airborne concentrations to the lowest feasible level. Wear personal protective clothing and equipment and respiratory protection. Inhaling or ingesting asbestos fibers from contaminated clothing or skin can be hazardous. *Do not* allow dusts and asbestos-containing wastes to accumulate.

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Storage Requirements: Store in closed (dust-tight) containers or heavy-gauge impervious plastic bags in a clean, secure area protected from physical damage. *Do not* open containers that can release asbestos dust without providing proper enclosure or control measure.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all operations and provide local exhaust ventilation and dust collection systems at the site of release to prevent airborne dispersion.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Administrative Controls: Educate workers about asbestos and asbestos-containing materials' hazards. Inform employees of asbestos standard (29 CFR 1910.1001). Exposure to asbestos, tremolite, anthophyllite, and actinolite in construction work is covered by 29 CFR 1926.58. Instruct employees in proper practices for handling asbestos-containing materials and correct use of protective equipment. Prevent or minimize asbestos exposure. Regulate areas where exposure in excess of the PEL is likely. Post warning signs in all regulated areas. Do not substitute personal protective equipment for proper handling and engineering controls. If exposures exceed the PEL, ensure employees wear appropriate protective clothing. Monitor work areas that expose employees to airborne concentrations at or above the action level (Sec. 2). Whenever production, process, control equipment, personnel, or work practices change, institute new monitoring. Medical surveillance is required for all employees possibly exposed at or above the action level. Provide preplacement medical examination that includes complete medical and work history, complete physical examination that emphasizes respiratory and cardiovascular systems and digestive tract, the respiratory disease standardized questionnaire, a posterior-anterior 14" x 17" chest roentgenogram, and pulmonary function tests [FVC and FEV(1)]. Annual periodic medical examinations shall include all these elements and an abbreviated questionnaire. Encourage smoking cessation due to synergistic effects of smoking and asbestos exposure. If it is 10+ years since first asbestos exposure, an individual should have a chest roentgenogram: every 5 years (ages 15 to 35), every 2 years (ages 35 to 45), every year (age 45+). Within 30 days of employment termination, an individual should receive a periodic medical examination with the elements listed above. Keep medical surveillance records for duration of employment, plus 30 years.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. At concentrations above the NIOSH REL or at any detectable concentration, wear any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (assigned protection factor = 10,000); or any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA or other positive-pressure mode (assigned protection factor = 10,000). For escape wear an air-purifying, full-facepiece respirator with a high-efficiency particulate filter; or any appropriate escape-type, SCBA. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear coveralls or gauntlets made of cotton polyester material; head-coverings; and foot coverings such as canvas booties, rubber galoshes or safety shoes. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Place contaminated protective devices or work clothing in labeled, impermeable, and sealed containers or bags. Separate contaminated work clothes from street clothes. *Do not* remove asbestos from clothing by blowing or shaking. Launder contaminated clothing before wearing. Inform laundering service of asbestos-contaminated clothing and of asbestos' potential harmful effects (29 CFR 1910.1001). A vacuum with HEPA filter may be used to remove asbestos fibers.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: White or greenish (chrysotile), blue (crocidolite), or gray-green (amosite) fibrous, odorless solids

Formula Weight: Varies with asbestos form (See Sec. 1)

Water Solubility: Insoluble

Melting Point: Decomposes

Section 10 - Stability and Reactivity

Stability: Asbestos is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Strong acids can attack chrysotile and rapidly extract its MgO and H_2O content; glacial acetic acid can decompose it. Hot water slowly breaks down chrysotile. Like other asbestos forms, it resists strong alkali [(5M NaOH at least up to 212 °F (100 °C)].

Conditions to Avoid: Airborne dispersion of asbestos fibers.

Hazardous Decomposition Products: It is heat resistant, but decomposes and alters its microscopic fiber structure above 1112 °F (600 °C). Chrysotile dehydroxylates at 1112 to 1436 °F (600 to 780 °C); the "asbestos anhydride" in turn breaks down to a mixture of silica (SiO_2) and fosterite (Mg_2SiO_4) at 1472 to 1562 °F (800 to 850 °C). Above 1832 °F (1000 °C), magnesium pyroxenes form and melt at ~2642 °F (1450 °C).

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Section 11 - Toxicological Information

Toxicity Data:*

Acute Inhalation Effects:
Human, inhalation, TC_{Lo}: 1.2 fb/cc/19 yr/continuous; toxic effects: pleural effusion, dyspnea, and sputum.
Genetic Effects:
E. coli: 10 mg/plate (+/-S9) produced mutations.
Tumorigenicity:
Rat, implant: 750 mg/kg; toxic effects: equivocal tumorigenic agent by RTECS criteria; tumors at site of application.
Mouse, intraperitoneal: 80 mg/kg; toxic effects: equivocal tumorigenic agent by RTECS criteria; tumors at site of application.
* NIOSH, *RTECS* (CI6475000; CAS No.: 1332-21-4)

Section 12 - Ecological Information

Environmental Fate: As a mineral asbestos is not affected by photolytic processes. It is considered to be nonbiodegradable by aquatic organisms; no evidence was found regarding bioaccumulation in aquatic organisms.
Soil Adsorption/Mobility: Although some trace metals and organic compounds have an affinity for asbestos minerals, asbestos itself does not have an adsorptive affinity for the solids normally found in natural water systems.

Section 13 - Disposal Considerations

Disposal: Asbestos is a poor candidate for incineration. Place asbestos and asbestos-containing wastes into good quality plastic bags and bury in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Asbestos
Shipping Symbols: D
Hazard Class: 9
ID No.: NA2212
Packing Group: III
Label: CLASS 9
Special Provisions (172.102): None listed

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.216
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 200 kg
b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 34, 40

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA, Sec. 307(a) and CAA, Sec. 112.
CERCLA Final Reportable Quantity (RQ), 1 lb (0.454 kg); the RQ is limited to friable forms only
Listed as a SARA Toxic Chemical (40 CFR 372.65), as asbestos (friable); effective date 1/1/87.
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
Listed as an OSHA Specifically Regulated Substance (29 CFR 1910.1001)

Section 16 - Other Information

References: 73, 103, 124, 136, 139, 147, 167, 184, 190, 197, 198, 209, 223 W5-Mac

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Industrial Hygiene Review ..... DJ Wilson, CIH
Medical Review ..... G Kelafant, MD

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Material Safety Data Sheets Collection:

Sheet No. 296
Arsenic and Compounds

Issued: 4/90

Section 1. Material Identification 31

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.
Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 1
I 4
S 2
K 0

Genium



HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL
8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

ACGIH TLV, 1989-90
TLV-TWA: 0.2 mg/m³

NIOSH REL, 1987
Ceiling: 0.002 mg/m³

Toxicity Data‡
Man, oral, TD_{Lo}: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
Rat, oral, TC_{Lo}: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.
† Inorganic compounds.
‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: sublimes at 1134 °F/612 °C
Melting Point: 1497 °F/814 °C
Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)
Atomic Weight: 74.92
Density: 5.724 at 57 °F/14 °C
Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid (HNO_3).

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, CO_2, water spray, or foam to fight fires.
Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.
Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.
Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.
Target Organs: Liver, kidneys, skin, lungs, lymphatic system.
Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.
Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).
Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: If emesis is unsuccessful after two doses of Ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations‡
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.
‡ Listed as arsenic organic compounds (as As).

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.

Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid
DOT Hazard Class: Poison B
ID No.: UN1558
DOT Label: Poison
DOT Packaging Requirements: 173.366
DOT Packaging Exceptions: 173.364

IMO Shipping Name: Arsenic, metallic
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II
ID No.: UN1558

MSDS Collection **References:** 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD M4

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Material Safety Data Sheets Collection:

Sheet No. 5
Chromic Acid and Chromates

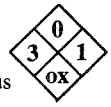
Issued: 10/77 Revision: C, 7/91 Errata: 12/94

Section 1. Material Identification

Chromic Acid (CrO_3) Description: Produced by roasting chromite ore with alkali or lime, leaching with calcium oxide, crystallizing the chromate or dichromate, and then treating it with an excess of sulfuric acid. Used in ceramic glazes, colored glass, dyes, batteries, explosives, water treatment, wood treatment and preservatives, refractories, copper stripping, aluminum anodizing, photomechanical processing, chromium metal plating, purifying oil and acetylene, hardening microscopic preparations, and manufacturing chromated copper arsenate; and as a corrosion inhibitor, a catalyst, an oxidizing agent in organic chemistry, and an etchant for plastics.

R 1
I 4
S 3*
K 0
* Percutaneous (broken skin)

NFPA



HMIS
H 3
F 0
R 1
PPG†
† Sec. 8

Other Designations: CAS No. 1333-82-0; chromic acid; chromic acid, solid (DOT); chromium anhydride; chromium (VI) oxide; chromium trioxide; chromium (6+) trioxide; monochromium trioxide; puratronic chromium trioxide. Chromic acid is the commonly used name, although true chromic acid (CrH_2O_4, CAS No. 7738-94-5) cannot be isolated from solution. Chromic acid and chromates (as CrO_3, CAS No. 7440-47-3).

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Caution: A powerful oxidizer, chromic acid may explode on contact with reducing agents and cause ignition on contact with organic materials. This poison and human carcinogen is corrosive to skin and irritating to mucous membranes. Eye contact may cause permanent blindness.

Section 2. Ingredients and Occupational Exposure Limits

Chromic acid, 99% CrO_3

1990 OSHA PEL
Ceiling: 0.1 mg(CrO_3)/m³

1987 IDLH Level
30 mg/m³

1990-91 ACGIH TLVs
TWA: 0.05 mg(Cr)/m³
Ceiling: 0.1 mg/m³

1990 NIOSH REL
TWA: 0.025 mg(Cr(VI))/m³
Ceiling: 0.05 mg/m³/15 min (Cr(VI))

1985-86 Toxicity Data*
Rat, oral, LD_{50}: 80 mg/kg
Mouse, oral, LD_{50}: 127 mg/kg
Human, inhalation, TC_{Lo}: exposed continuously to 110 µg over 3 years. Toxic effects include tumorigenic (carcinogenic by *RTECS* criteria); sense organs and special senses (olfaction tumors); lungs, thorax, or respiration (tumors).
Dog, subcutaneous, LD_{Lo}: 330 mg/kg

* See NIOSH, *RTECS* (GB6650000), for additional mutative, reproductive, toxicity and tumorigenic data.

Section 3. Physical Data*

Boiling Point: Decomposes at 482 °F (250 °C) to $Cr_2O_3 + O_2$
Melting Point: 385 °F (196 °C)
Molecular Weight: 99.98

Specific Gravity: 2.7
Water Solubility: Soluble
Heat of Fusion: 37.7 cal/g

Appearance and Odor: Dark, purplish-red, prismatic, deliquescent (absorbs all moisture from air) crystals, or a granular powder with no detectable odor.

* These physical data apply only to chromic acid (CAS No. 1333-82-0).

Section 4. Fire and Explosion Data

Flash Point: None reported	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: Chromic acid is noncombustible, but accelerates burning of combustibles (wood, paper, oil). For small fires, *use only water,* not dry chemical, carbon dioxide (CO_2), or halon.

Unusual Fire or Explosion Hazards: A powerful oxidizer, chromic acid ignites on contact with acetic acid and alcohol. It may react rapidly enough with organic materials to cause ignition. Containers may explode if involved in fire.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Cool fire-exposed containers with flooding amounts of water since the decomposing material may form a hot, viscous foam that can cause containers to rupture and explode. *Use caution!* For large fires, flood area from a safe distance, and cool containers from the side with a water spray until after fire is well out. If possible without risk, move containers. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holder. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Chromic acid is generally stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: This material is incompatible with acetic acid, acetic anhydride, acetone, alcohols, alkali metals, ammonia, arsenic, anthracene, benzene, bromine penta fluorine, butyric acid, camphor, chromous sulfide, diethyl ether, glycerol, hydrogen sulfide, methyl alcohol, naphthalene, peroxyformic acid, phosphorus, potassium hexacyanoferrate, pyridine, selenium, sodium, and turpentine. Chromic acid ignites ethyl alcohol and many hydrocarbons.

Conditions to Avoid: Avoid excess heat and contact with combustible or organic materials.

Hazardous Products of Decomposition: Thermal oxidative decomposition of chromic acid can produce carbon dioxide, smoke, and irritating toxic fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC and NTP list chromic acid and other forms of hexavalent (VI) chromium as human carcinogens.

Summary of Risks: Chromic acid is a poison and a powerful irritant to skin, eyes, and respiratory tract. Skin or lung sensitization (allergic reactions) may occur. Exposure can cause dermatitis (skin rash), asthma, pulmonary edema (fluid in lungs), kidney damage, a "chrome hole," or a perforation of the nasal septum (tissue between nostrils).

Medical Conditions Aggravated by Long-Term Exposure: Any chronic lung or skin condition.

Target Organs: Skin, respiratory tract (including nose, throat, airways, and lungs), and kidney.

Primary Entry Routes: Eyes, skin contact, inhalation, and ingestion.

Acute Effects: Inhalation may cause irritation or burning of nose, throat, and air passages, cough, wheezing, and shortness of breath. Higher exposures may cause pulmonary edema (fluid in lungs). Skin exposure may cause dermatitis (skin rash), irritation, burning, itching, redness, and ulceration (skin destruction) which may penetrate. Eye contact can cause irritation, burning, lacrimation (watering), loss of sight and permanent blindness if not removed quickly.

Chronic Effects: Chronic inhalation of excessive levels may cause epistaxis (nosebleed), "chrome holes," nasal congestion, tooth enamel erosion, chest pain, asthma (via allergic sensitization), bronchitis, or respiratory tract cancer. Chronic eye exposure may cause conjunctivitis. Skin contact

Continue on next page

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Section 6. Health Hazard Data, *continued*

can cause irritant or allergic contact dermatitis, or skin ulceration. Chronic systemic absorption could cause liver or kidney damage.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do not let victim rub eyes or keep them tightly shut. Consult a physician immediately.

Skin: Rinse with flooding amounts of water for at least 15 min, and wash with a gentle soap. Promptly remove contaminated clothing. For redness, blistering, or persistent irritation, consult a physician.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water. *Do not induce vomiting* since this worsens the victim's condition. *Do not* neutralize this acid.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: After decontamination and neutralization, treatment of acid burns is similar to that of thermal burns, although bullae and loose necrotic tissue should be debrided. Update tetanus status. *For severe acid burns,* fluid resuscitation is critical to prevent mortality from hypovolemia and renal failure. Monitor serial vital signs, urine output, electrolytes, blood count, and urinalysis as clinically indicated. Neurovascular compromise distal to a circumferential extremity burn may require escharotomy or fasciotomy. *For inhalation exposures to acids,* a CXR, EKG, ABGs, PFTs, SMA, and CBC may aid in treatment. Evaluate and treat as indicated for reactive airways, upper airway obstruction and noncardiogenic pulmonary edema (possibly delayed onset). Although literature documentation is inadequate, a burst of steroids may help prevent development of sequelae such as reactive airways dysfunction syndrome or bronchilitis obliterans. For ocular exposures to acids, ensure adequate decontamination. Determination of pH may be helpful. A Morgan Lens© and topical anesthesia may aid in irrigation. Perform fluorescein staining and slit lamp evaluation and consult an opthamalogist. Antibiotic ointments, mydriatic/cycloplegics, topical corticosteroids (after epithelial recovery), patching, and possibly anterior chamber paracentesis may be indicated depending on clinical presentation. Acutely and in follow-up, evaluate as indicated for intraocular pressure, lacrimal and lid function, corneal integrity and infection. Urinary chromium is of questionable value.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel. Cleanup personnel should protect against dust inhalation and eye contact. Do not handle broken packages unless wearing appropriate personal protective equipment. Keep combustibles (wood, paper, etc.) away from spilled material. Whenever possible, use wet cleanup methods; if not, use vacuum cleanup. Remove spills immediately to prevent dust dispersion. For a water spill, neutralize with agricultural lime, crushed limestone, or sodium bicarbonate. For a land spill, dig a pit, pond, or lagoon to contain material. If time permits, seal these with an impermeable, flexible membrane liner. Dike surface flow with soil, sand or foamed concrete. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Transport: If allowed contact with soil, chromic acid, solid, lowers pH and may leach into water sources, causing an effect similar to acid rain's on water sources. This material's carcinogenicity makes it hazardous to the environment in its hexavalent state.

Environmental Degradation: The recommended disposal means are reduction, precipitation, or ion exchange. Landfill disposal is not recommended since it raises soil acidity.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.22): Corrosive waste
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [*per Clean Water Act, Sec. 311(b)(4)]†
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

† Chromic acid (CAS No. 7738-94-5) is listed.

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For 0.5 mg/m^3 concentrations (if not fumes), use any dust and mist respirator except single-use and quarter-mask respirators. For 1.25 mg/m^3 concentrations, use any powered air-purifying respirator with a high-efficiency particulate filter. For 2.5 mg/m^3 concentrations, use any air-purifying full facepiece respirator with a high-efficiency particulate filter. For 30 mg/m^3 concentrations, use any supplied air respirator with a full facepiece and operated in a pressure-demand or other positive-pressure mode. All concentrations may require eye protection. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below occupational exposure levels. Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.[103]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Contact lenses may minimize or worsen eye injuries. In some cases, soft lenses can actually protect eyes, not worsen corneal damage, due to strong chemicals. In other cases, chemical entrapment is presumed a possible hazard. Since contact lens use in industry is controversial, establish your own policy. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in glass bottles, cans, or drums. Protect against physical damage. Separate from combustible, organic, or other easily oxidizable materials. Protect from excess moisture which could cause containers to rust. Do not store on wooden floors. Store away from foodstuffs and flammable liquids and solids.

Engineering Controls: Avoid dust inhalation and skin or eye contact. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good housekeeping procedures.

Other Precautions: Institute preplacement and periodic medical exams of exposed workers with attention to the skin and respiratory tract. Consider preplacement and periodic chest radiographs.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Chromic acid, solid
DOT Hazard Class: Oxidizer
ID No.: NA1463
DOT Label: Oxidizer
DOT Packaging Exceptions: 173.153
DOT Packaging Requirements: 173.164

IMO Shipping Name: Chromium trioxide, anhydrous
IMO Hazard Class: 5.1
ID No.: UN1463
IMO Label: Oxidizer, Corrosive
IMDG Packaging Group: II

MSDS Collection **References:** 26, 38, 73, 85, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 143, 142, 145, 148, 159

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 686
Hydrogen Cyanide

Issued: 8/89

Section 1. Material Identification

29

Hydrogen Cyanide Description: Large-scale preparation by the catalytic oxidation of ammonia-methane mixtures. Used in the fumigation of ships, railroad cars, orchards, buildings, tabacco, and various foods. Can be produced in petroleum refining, electroplating, metallurgy, and photographic development.
Other Designations: Hydrocyanic acid; prussic acid; anhydrous hydrogen cyanide; HCN; CAS No. 0074-90-8.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S -
K 4



NFPA

HMIS
H 4
F 4
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Hydrogen cyanide, ca 100%

OSHA PEL (Skin*)
Ceiling: 10 ppm, 10 mg/m³

ACGIH TLV (Skin*), 1988-89
TLV Ceiling: 10 ppm, 10 mg/m³

NIOSH REL, 1976
10-min ceiling: 4.7 ppm CN, 5 mg CN/m³

Toxicity Data†
Human, oral, LD_{Lo}: 570 µg/kg
Human, inhalation, LC_{Lo}: 200 mg/m³/10 min
Rat, inhalation, LC_{50}: 484 ppm/5 min

* This material can be absorbed through intact skin, which contributes to overall exposure.
† See NIOSH, *RTECS* (MW6825000), for additional data with references.

Section 3. Physical Data

Boiling Point: 79 °F (29 °C)
Melting Point: 7.88 °F (-13.4 °C)
Vapor Pressure: 620 torr at 68 °F (20 °C)
Vapor Density (Air = 1): 0.941

Molecular Weight: 27 g/mol
Specific Gravity (H_2O = 1): 0.7
Water Solubility: Miscible
% Volatile by Volume: 100

Appearance and Odor: A colorless gas or blue-white liquid; a characteristic faint odor resembling bitter almonds for those individuals able to perceive its presence by smell.

Section 4. Fire and Explosion Data

Flash Point: 0 °F (-17.78 °C) CC	**Autoignition Temperature:** 1000 °F (538 °C)	**LEL:** 5.6% v/v	**UEL:** 40% v/v

Extinguishing Media: Hydrogen cyanide is an extremely toxic, flammable material. In advanced or massive fires, firefighting should be done from a safe, protected location. Use carbon dioxide (CO_2), dry chemical, or foams to put out hydrogen cyanide fires. Use water sprays to cool fire-exposed containers, protect the personnel attempting to seal the source of the leaking gas, flush spills away from sensitive exposures (heat, sources of ignition, or incompatible chemicals), disperse the vapors, and dilute spills to nonflammable mixtures.
Unusual Fire or Explosion Hazards: This gas is extremely poisonous and flammable. Consider evacuation of the incident area in large fires.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Fire fighters must wear a complete set of personal protective equipment to prevent virtually any contact with this deadly poison. They must not have exposed skin surfaces since their skin can absorb fatal amounts of hydrogen cyanide.

Section 5. Reactivity Data

Stability/Polymerization: Hydrogen cyanide is stable at room temperature in during routine operations.. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Hydrogen cyanide can react dangerously with acetaldehyde.
Conditions to Avoid: *Specially trained personnel must handle hydrogen cyanide. Never permit inexperienced workers to handle it.* Never expose this material to any heat or ignition sources such as lighted cigarettes or pipes, open flames, or uninsulated heating elements.
Hazardous Products of Decomposition: Thermal oxidative degradation of hydrogen cyanide can produce carbon dioxide, toxic oxides of nitrogen (N_xO_y) and carbon monoxide (CO). Hydrogen cyanide is a very toxic material even when not decomposed during fires.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists hydrogen cyanide as a carcinogen.
Summary of Risks: Inhalation of high concentrations of hydrogen cyanide causes tachypnea (rapid breathing) resulting in increased cyanide intake; then dyspnea, paralysis, convulsions, and respiratory arrest. Death may occur within minutes. Lesser concentrations can cause headache, vertigo, nausea, and vomiting. Concentrations of 270 ppm are immediately fatal; 181 ppm in 10 min are fatal; 135 ppm in 30 min are fatal; 110 to 135 ppm in 1 hr are potentially fatal; 45 to 54 ppm are tolerable for 30 to 60 min without immediate or late effects; and 18 to 36 ppm cause slight symptoms after several hours of exposure. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** All body cells. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Burning sensation in mouth and throat. Initially rapid pulse and high blood pressure followed by decreasing blood pressure and pulse. Cherry-red mucous membranes may be noted. Headache, weakness, mental

Continue on next page

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Section 6. Health Hazard Data (continued)

confusion, nausea, vomiting, shock, convulsions, coma, and possible death. **Chronic Effects:** Enlargement of the thyroid gland, fatique, weakness, headache, changes in taste and smell, irritation of throat, effort dyspnea, nervous instability, lachrymation, abdominal colic, and precordial pain were reported in workers exposed at concentrations between 4 and 12 ppm for approximately 7 years.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min. **Skin:** Immediately remove all contaminated clothing. After rinsing affected area with flooding amounts of water, wash it with soap and water. Avoid contact with this chemical. **Inhalation:** Remove the exposed person to fresh air and support breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion:** Never induce vomiting or perform mouth-to-mouth respiration! Provide 100% oxygen as soon as possible. Institute gastric lavage after endotracheal intubation. **After first aid, get appropriate in-plant, paramedic, or community medical attention and support.** Seek prompt medical assistance for further observation and treatment.

Physician's Note: *Treat all exposures as life-threatening emergencies.* An antidote to hydrogen cyanide is sodium nitrite and sodium thiosulfate. Commercially available cyanide poisoning first-aid kits should be purchased. Competent medical personnel should carefully train appropriately selected workers on how to use these kits in emergencies. Several detailed medical treatments are available for cyanide poisoning. After reviewing the specific uses of hydrogen cyanide in their operation, the safety personnel and/or the industrial hygienists should develop a precise emergency first-aid treatment protocol before an incident occurs. Heart monitorings should be instituted.

Section 7. Spill, Leak, and Disposal Procedures

Spill Leak: *Design and practice a hydrogen cyanide spill control and countermeasure plan (SCCP). Immediately evacuate the incident area and alert the appropriate local officials to the specifics of the hydrogen cyanide release.* When a spill occurs, notify safety personnel, eliminate heat or ignition sources, provide optimum explosion-proof ventilation, and implement the SCCP. Cleanup personnel must wear a complete ensemble of personal protective equipment (Sec. 8), including self-contained breathing apparatus and total body-covering clothes, to prevent skin contact or inhalation. Use nonsparking tools and equipment. Use water sprays to protect personnel attempting to locate and seal the source of the escaping hydrogen cyanide gas. **Waste Management/ Disposal:** Contact your supplier or a licensed contrator for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as Air Contaminant (29 CFR 1910.1000, Subpart Z)

EPA Designations

Listed as RCRA Hazardous Waste No. P063 (40 CFR 261.33)

Listed aa a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [* per CWA, Sec. 311(b)(4) and RCRA, Sec. 3001]

SARA Extremely Hazardous Substance (40 CFR 355), Threshold Planning Quantity (TPQ): 100 lb

SARA Toxic Chemical* (40 CFR 372.65) [* EPA Form R may apply to your facility; see 40 CFR 372.85 for instructions]

Section 8. Special Protection Data

Goggles: Always wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Other:** Use hydrogen cyanide in closed-confinement, pressurized engineering systems. Automatic shutoff valves/sensors to the main feed lines are recommended in the event of a catastrophic pressure drop from the rupture of a pressurized HCN pipeline. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store hydrogen cyanide in tightly closed, airtight, moisture-proof containers in a cool, dry, well-ventilated, fireproof area away from heat or ignition sources and incompatible chemicals (Sec. 5.) Protect these containers from physical damage; shield them from direct sunlight. Limit access to the storage area to authorized personnel only. **Special Handling/Storage:** Proper stock rotation of hydrogen cyanide is vital for safety. Individual HCN cylinders should not be sored longer than 90 days. Check with your supplier for detailed recommendations concerning proper shelf rotation of stock, and proper dispensing equipment such as valves, flanges, and manifolds. **Engineering Controls:** To prevent static sparks, electrically ground and bond all containers, cylinders, and pipelines used in shipping, receiving, or transferring operations in production and storage areas. **Other Precautions:** Consider installing automatic sensing equipment which alerts workers to airborne concentrations of hydrogen cyanide greater than the 10 ppm ceiling (Sec. 2).

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Hydrocyanic acid solution
DOT Hazard Class: Poison A *or* Poison B
DOT ID No. : UN1613 *or* NA1051
DOT Label: Poison gas and flammable gas

IMO Shipping Name: Hydrogen cyanide
IMO Hazard Class: 6.1
IMO Label: Poison and flammable liquid
IMDG Packaging Group: I

Proper shipping names, hazard classes, labels, and identification numbers vary with the hydrogen cyanide's concentration or strength.

MSDS Collection **References:** 1, 6, 7, 84-94, 100, 116, 117, 119, 120, 122

Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 52
Hydrogen Sulfide

Issued: 7/79 Revision: B, 9/92

Section 1. Material Identification

39

Hydrogen Sulfide (H_2S) Description: Formed as a byproduct of many industrial processes (breweries, tanneries, slaughter houses), around oil wells, where petroleum products are used, in decaying organic matter, and naturally occurring in coal, natural gas, oil, volcanic gases, and sulfur springs. Derived commercially by reacting iron sulfide with dilute sulfuric or hydrochloric acid, or by reacting hydrogen with vaporized sulfur. Used in the production of various inorganic sulfides and sulfuric acid, in agriculture as a disinfectant, in the manufacture of heavy water, in precipitating sulfides of metals; as a source of hydrogen and sulfur, and as an analytical reagent.

R 2
I 4
S 3
K 3

NFPA



HMIS
H 3
F 4
R 0
PPE*
* Sec. 8

Other Designations: CAS No. 7783-06-4, dihydrogen monosulfide, hydrosulfuric acid, sewer gas, stink damp, sulfuretted hydrogen, sulfur hydride.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Hydrogen sulfide is a highly flammable gas and reacts vigorously with oxidizing materials. It is highly toxic and can be instantly fatal if inhaled at concentrations of 1000 ppm or greater. Be aware that the sense of smell becomes rapidly fatigued at 50 to 150 ppm, and that its strong rotten-egg odor is not noticeable even at very high concentrations.

Section 2. Ingredients and Occupational Exposure Limits

Hydrogen sulfide: 98.5% *technical*, 99.5% *purified*, and CP *(chemically pure grade)*

1991 OSHA PELs
8-hr TWA: 10 ppm (14 mg/m^3)
15-min STEL: 15 ppm (21 mg/m^3)

1990 IDLH Level
300 ppm

1990 NIOSH REL
10-min Ceiling: 10 ppm (15 mg/m^3)

1992-93 ACGIH TLVs
TWA: 10 ppm (14 mg/m^3)
STEL: 15 ppm (21 mg/m^3)

1990 DFG (Germany) MAK
TWA: 10 ppm (15 mg/m^3)
Category V: Substances having intense odor
Peak exposure limit 20 ppm, 10 min momentary value, 4/shift

1985-86 Toxicity Data*
Human, inhalation, LC_{Lo}: 600 ppm/30 min; toxic effects not yet reviewed
Man, inhalation, LD_{Lo}: 5700 µg/kg caused coma and pulmonary edema or congestion.
Rat, intravenous, LD_{50}: 270 µg/kg; no toxic effect noted

* See NIOSH, *RTECS* (MX1225000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: -76 °F (-60 °C)
Freezing Point: -122 °F (-86 °C)
Vapor Pressure: 18.5 atm at 68 °F (20 °C)
Vapor Density (Air = 1): 1.175
pH: 4.5 (freshly prepared saturated aqueous solution)
Viscosity: 0.01166 cP at 32 °F/0 °C and 1 atm
Liquid Surface Tension (est): 30 dyne/cm at -77.8 °F/-61 °C

Molecular Weight: 34.1
Density: 1.54 g/L at 32 °F (0 °C)
Water Solubility: Soluble*; 1g/187 mL (50 °F/10 °C), 1g/242 mL (68 °F/20 °C), 1g/ 314 mL (86 °F/30 °C)
Other Solubilities: Soluble in ethyl alcohol, gasoline, kerosine, crude oil, and ethylene glycol.
Odor threshold: 0.06 to 1.0 ppm†

Appearance and Odor: Colorless gas with a rotten-egg smell.

* H_2S solutions are not stable. Absorbed oxygen causes turbidity and precipitation of sulfur. In a 50:50 mixture of water and glycerol, H_2S is stable.
† Sense of smell becomes rapidly fatigued and can not be relied upon to warn of continuous H_2S presence.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: 500 °F (260 °C)	LEL: 4.3% v/v	UEL: 46% v/v

Extinguishing Media: Let small fires burn unless leak can be stopped immediately. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** H_2S burns with a blue flame giving off sulfur dioxide. Its burning rate is 2.3 mm/min. Gas may travel to a source of ignition and flash back. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing is not effective for fires involving H_2S. If possible without risk, stop leak. Use unmanned device to cool containers until well after fire is out. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: H_2S is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Hydrogen sulfide attacks metals forming sulfides and is incompatible with 1,1-bis(2-azidoethoxy) ethane + ethanol, 4-bromobenzenediazonium chloride, powdered copper + oxygen, metal oxides, finely divided tungsten or copper, nitrogen trichloride, silver fulminate, rust, soda-lime, and all other oxidants. **Conditions to Avoid:** Exposure to heat and contact with incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of hydrogen sulfide can produce toxic sulfur dioxide .

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list hydrogen sulfide as a carcinogen. **Summary of Risks:** H_2S combines with the alkali present in moist surface tissues to form caustic sodium sulfide, causing irritation of the eyes, nose, and throat at low levels (50 to 100 ppm). Immediate death due to respiratory paralysis occurs at levels greater than 1000 ppm. Heavy exposure has resulted in neurological problems, however recovery is usually complete. H_2S exerts most of it's toxicity on the respiratory system. It inhibits the respiratory enzyme cytochrome oxidase, by binding iron and blocking the necessary oxydo-reduction process. Electrocardiograph changes after over-exposure have suggested direct damage to the cardiac muscle, however some authorities debate this. **Medical Conditions Aggravated by Long-Term Exposure:** Eye and nervous system disorders. **Target Organs:** Eyes, respiratory system and central nervous system. **Primary Entry Routes:** Inhalation, eye and skin contact. **Acute Effects:** Inhalation of low levels can cause headache, dizziness, nausea, cramps, vomiting, diarrhea, sneezing, staggering, excitability, pale

Continued on next page

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Section 6. Health Hazard Data, *continued*

complexion, dry cough, muscular weakness, and drowsiness. Prolonged exposure to 50 ppm, can cause rhinitis, bronchitis, pharyngitis, and pneumonia. High level exposure leads to pulmonary edema (after prolonged exposure to 250 ppm), asphyxia, tremors, weakness and numbing of extremeties, convulsions, unconsciousness, and death due to respiratory paralysis. Concentrations near 100 ppm may be odorless due to olfactory fatigue, thus the victim may have no warning. Lactic acidosis may be noted in survivors. The gas does not affect the skin although the liquid (compressed gas) can cause frostbite. The eyes are very susceptible to H_2S keratoconjunctivitis known as 'gas eye' by sewer and sugar workers. This injury is characterized by palpebral edema, bulbar conjunctivitis, mucous-puss secretions, and possible reduction in visible capacity. **Chronic Effects:** Chronic effects are not well established. Some authorities have reported repeated exposure to cause fatigue, headache, inflammation of the conjunctiva and eyelids, digestive disturbances, weight loss, dizziness, a grayish-green gum line, and irritability. Others say these symptoms result from recurring acute exposures. There is a report of encephalopathy in a 20 month old child after low-level chronic exposure. **FIRST AID Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water. Treat with boric acid or isotonic physiological solutions. Serious exposures may require adrenaline drops. Olive oil drops (3 to 4) provides immediate treatment until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing and rinse with flooding amounts of water. For frostbite, rewarm in 107.6°F (42 °C) water until skin temperature is normal. *Do not* use dry heat. **Inhalation:** Remove exposed person to fresh air and administer 100% oxygen. Give hyperbaric oxygen if possible. **Ingestion:** Unlikely since H_2S is a gas above -60 °C. **Note to Physicians:** The efficacy of nitrite therapy is unproven. Normal blood contains < 0.05 mg/L H_2S; reliable tests need to be taken within 2 hr of exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. Use water spray to cool, dilute, and disperse vapors. Neutralize runoff with crushed limestone, agricultural (slaked) lime, or sodium bicarbonate. If leak can't be stopped in place, remove cylinder to safe, outside area and repair or let empty. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, TLm = 0.0448 mg/L/96 hr at 71.6 °F/22 °C; fathead minnow, TLm = 0.0071 to 0.55 mg/L/96 hr at 6 to 24 °C. **Environmental Degradation:** In air, hydrogen sulfides residency (1 to 40 days) is affected by temperature, humidity, sunshine, and the presence of other pollutants. It does not undergo photolysis but is oxidated by oxygen containing radicals to sulfur dioxide and sulfates. In water, H_2S converts to elemental sulfur. In soil, due to its low boiling point, much of H_2S evaporates quickly if spilled. Although, if soil is moist or precipitation occurs at time of spill, H_2S becomes slightly mobile due to its water solubility. H_2S does not bioaccumulate but is degraded rapidly by certain soil and water bacteria. **Disposal:** Aerate or oxygenate with compressor. For in situ amelioration, carbon removes some H_2S. Anion exchanges may also be effective. A potential candidate for rotary kiln incineration (1508 to 2912 °F/820 to 1600 °C) or fluidized bed incineration (842 to 1796 °F/450 to 980 °C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U135
SARA Toxic Chemical (40 CFR 372.65): Not listed
Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 500 lb
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001 & CWA, Sec. 311 (b)(4)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A & Z-2)
Listed as a Process Safety Hazardous Material (29 CFR 1910.119), TQ: 1500 lb

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 100 ppm, use a supplied-air respirator (SAR) or SCBA. For < 250 ppm, use a SAR operated in continuous-flow mode. For < 300 ppm, use a SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: a written program, medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polycarbonate, butyl rubber, polyvinyl chloride, and neoprene are suitable materials for PPE. **Ventilation:** Provide general & local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in steel cylinders in a cool, dry, well-ventilated area away from incompatibles (Sec. 5). Install electrical equipment of Class 1, Group C. Outside or detached storage is preferred. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to keep levels as low as possible. Enclose processes and continuously monitor H_2S levels in the plant air. Keep pipes clear of rust as H_2S can ignite if passed through rusty pipes. Purge and determine H_2S concentration before entering a confined area that may contain H_2S. The worker entering the confined space should have a safety belt and life line and be observed by a worker from the outside. Follow applicable OSHA regulations (1910.146) for confined spaces. H_2S can be trapped in sludge in sewers or process vessels and may be released during agitation. Calcium chloride or ferrous sulfate should be added to neutralize process wash water each time H_2S formation occurs. Control H_2S emissions with a wet flare stack/scrubbing tower. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers emphasizing the eyes, nervous and respiratory system.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Hydrogen sulfide, liquefied
DOT Hazard Class: 2.3
ID No.: UN1053
DOT Packaging Group: --
DOT Label: Poison Gas, Flammable Gas
Special Provisions (172.102): 2, B9, B14

Packaging Authorizations
Exceptions: --
Non-bulk Packaging: 304
Bulk Packaging: 314, 315

Vessel Stowage Requirements
Vessel Stowage: D
Other: 40

Quantity Limitations
Passenger, Aircraft, or Railcar: Forbidden
Cargo Aircraft Only: Forbidden

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 136, 140, 148, 149, 153, 159, 163, 164, 168, 171, 180
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification 32

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R	0
I	4
S	-
K	0

Genium



HMIS
H 3
F 1
R 0
PPG*

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. * Sec. 8
Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 µg/m³
Action Level TWA*: 30 µg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 µg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 µg/m³

1988 NIOSH REL
10-hr TWA: <100 µg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 µg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system . The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

MSDS Collection **References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheet Collection

Selenium **MSDS No. 136**

Date of Preparation: 4/88 Revision: A, 3/98

Section 1 - Chemical Product and Company Identification 51

Product/Chemical Name: Selenium
Chemical Formula: Se
CAS Number: 7782-49-2
Synonyms: C.I. 77805; colloidal selenium; elemental selenium; EPA pesticide chemical code 072001; gray selenium; selen (Polish); selenate; selenium alloy; selenium base; selenium (colloidal); selenium dust; selenium elemental; selenium homopolymer; selenium powder; Vandex
Derivation: Recovered by roasting anode muds from electrolytic copper refineries with soda or sulfuric acid, or by smelting them with soda and niter.
General Use: Used as a pigment and decolorizing agent in the glass industry; in toning baths in photography; in making electrodes for arc lights, electrical instruments and apparatus; rectifier in radio and television sets; in semiconductor fusion mixtures, selenium cells, telephotographic apparatus; rubber vulcanizing agent; catalyst in determination of Kjeldahl nitrogen; for dehydrogenation of organic compounds; in steel and copper (degasifier and machineability improver); as a dietary supplement; in the manufacture of pigments, textiles, petroleum, and medical therapeutic agents.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Selenium, > 99% wt (commercial grade)
Trace Impurities (commercial grade): > 0.2% tellurium, 0.1% iron, 0.005% lead and 0.005% copper.

OSHA PEL
8-hr TWA: 0.2 mg/m^3

ACGIH TLV
TWA: 0.2 mg/m^3
Excursion Limit: Provided the TLV-TWA is not exceeded, exposure may exceed 0.6 mg/m^3 for no more than 30 min/day; never exceed 1.0 mg/m^3.

NIOSH REL
10-hr TWA: 0.2 mg/m^3

IDLH Level
1 mg/m^3

DFG (Germany) MAK
TWA*: 0.1 mg/m^3
Category III: Substances with systemic effects (Onset of effect > 2 hr); Half-life > shift length (strongly cumulative)

Peak Exposure Limit:
1.0 mg/m^3, 30 min, average value, 1/shift

*Measured as the inhalable fraction of the aerosol.

Section 3 - Hazards Identification

ANSI Signal Word: Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Selenium exists as an amorphous red or black solid, or red, gray or black crystals; upon heating, it emits an odor of garlic or rotten horseraddish. Selenium fumes or dust are irritating to the eyes, skin, and mucous membranes. Inhalation of fumes may also result in respiratory system impairment, and central nervous system (CNS) and psychological effects. This combustible solid may burn, but does not ignite readily. Heating selenium can produce fumes of toxic selenium oxides (*e.g.*, selenium dioxide (SeO_2)).

Wilson Risk Scale	
R	1
I	3
S	1
K	1

HMIS	
H	1*
F	1
R	1
PPE†	

*Chronic effects
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin and/or eye contact/absorption
Target Organs: Eyes, skin, CNS, cardiovascular system (CVS), respiratory system, blood, liver, kidneys, spleen
Acute Effects

Inhalation: Inhalation of selenium dust or fumes (fumes contain selenium dioxide - see Skin, below) may cause mucous membrane irritation, coughing, sneezing, breathing difficulty, shortness of breath, "metal fume fever" (chills, fever, headaches), hypotension (low blood pressure), psychological effects (depression, irritability, etc.), liver and kidney damage, and in extreme cases, pulmonary edema (accumulation of fluid in the lungs), CNS depression, and coma. Note that toxicity of selenium (elemental) is considerably less than that of selenium compounds. Toxic effects of selenium fume inhalation may largely be due to selenium dioxide content of fumes.

Eye: Exposure to dust or fumes may result in irritation, swelling and redness of the eyelids.

Skin: Exposure to selenium fumes causes irritation, contact dermatitis and burns (fumes contain selenium dioxide which forms selenious acid (irritant) upon contact with moist skin or mucous membranes. Both selenium dioxide and selenious acid can also be absorbed through the skin, and produce systemic toxicity).

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Ingestion: Acute systemic effects (see Inhalation) may result, although intestinal absorption of elemental selenium is minimal. Toxic effects ahve been reported following excessive consumption of dietary supplements.

Carcinogenicity: IARC lists selenium as Group 3 (Not classifiable as to carcinogenicity to humans); NTP, Class 2B (Reasonably anticipated to be a carcinogen, sufficient evidence of carcinogenicity from studies in experimental animals); EPA, Class D (Not classifiable as to human carcinogenicity). OSHA does not list selenium as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Asthma, allergies, known sensitization to selenium, chronic respiratory disease, gastrointestinal disturbances, liver or kidney disorders, dermatitis.

Chronic Effects: Bronchial irritation (through inhalation), inflammation of eye lining and lids, gastrointestinal distress, persistent garlic odor on breath, increased dental carries, mottled teeth, metallic taste, pallor, skin lesions, lowered blood clotting efficiency and hemoglobin levels, irritability, excessive fatigue, anorexia, pain or anesthesia in extremities, and, in extreme cases of "selenosis," skin discoloration (reddish), fingernail and hair discoloration or loss can result. Some individuals may be more sensitive than others to selenium toxicity. Reported daily ingestion of 27 to 2310 mg resulted in nausea, vomiting, nail changes, fatigue, and irritability. Lower selenium intake (700-800 µg/day) has not been found to produce toxic effects. Animal testing suggests spleen, liver and kidney damage, and reproductive effects.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain and/or irritation develop.

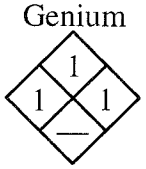
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Consider also administration of charcoal slurry cathartic.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treat overexposure symptomatically and supportively. Monitor whole blood selenium levels.

Section 5 - Fire-Fighting Measures



Flash Point: Not applicable; combustible solid.

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Flammability Classification: Combustible solid

Extinguishing Media: Use extinguishing agents suitable for surrounding fire.

Unusual Fire or Explosion Hazards: Containers may explode in heat of fire.

Hazardous Combustion Products: Heating selenium can produce toxic selenium oxides (*e.g.*, selenium dioxide (SeO_2)).

Fire-Fighting Instructions: *Do not* release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Isolate spill area for at least 80-160 feet (25-50 m). *Do not* touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. *Do not* get water inside containers.

Small Spills: Vacuum or carefully scoop up material and deposit in sealed containers.

Large Spills

Containment: Dike far ahead of spill for later disposal. *Do not* release into sewers or waterways.

Cleanup: Spills of selenium in waterways may be remediated by dredging.

Regulatory Requirements: None reported.

Section 7 - Handling and Storage

Handling Precautions: Avoid dust or fume inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves and clothing (see Sec. 8). Keep away from heat and ignition sources.

Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Periodically inspect stored materials.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

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Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose operations and/or provide local exhaust ventilation at the site of chemical release.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Where possible, use a contained transfer method for transferring selenium from drums or other storage containers to process containers. Arrange pre-employment and annual medical examinations emphasizing urinary selenium (should be < 0.1 mg/L), eyes, skin (chronic disorders), respiratory system, liver, kidneys, blood, and medical conditions aggravated by long-term exposure to selenium (see Sec. 3). Give special consideration to women of childbearing age, because of possible reproductive effects. Remove workers from selenium exposure if exposure-related garlic odor of breath is detected.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations ≤ 1 mg/m^3, use a dust and mist, or dust, mist and fume respirator, or air-purifying full face-piece respirator with high efficiency particulate (HEP) filter, or powered air-purifying respirator with dust and mist filter, or powered air-purifying respirator with dust, mist and fume filter, supplied air respirator, or SCBA with full facepiece; > IDLH/unknown/emergency, SCBA with full facepiece operated in pressure-demand or other positive-pressure mode, or supplied air respirator with full facepiece operated in pressure-demand or other positive-pressure mode in combination with SCBA. For escape, use an air-purifying, full facepiece respirator with HEP filter. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear impervious, chemically protective neoprene or rubber gloves, boots, aprons, gauntlets and body-covering clothing to prevent skin contact. Wear protective eyeglasses, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Amorphous or crystalline solid

Appearance and Odor: Red to bluish black, dark red, gray, or black, crystals odorless

Vapor Pressure: > 0.001 mm Hg at 68 °F (20 °C)

Formula Weight: 78.96 +/- 3

Specific Gravity (H_2O=1, at 4 °C): 4.26 to 4.81

Water Solubility: Insoluble

Other Solubilities: Soluble in sulfuric acid, carbon disulfide, ether, methylene iodide, benzene, quinoline, chloroform, aqueous potassium cyanide solution, potassium sulfite solution, caustic alkali solution. Insoluble in alcohol.

Boiling Point: 1274 °F (690 °C)

Melting Point: 338 °F (170 °C) to 422.6 °F (217 °C) (crystals)

Surface Tension: 92.5 dynes/cm at 423 °F (217 °C)

Ionization Potential (eV): 9.75238

Section 10 - Stability and Reactivity

Stability: Selenium is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include acids, fluorine, oxygen, cadmium, potassium, sodium, chlorine trifluoride, chromium trioxide, chromic oxide, lithium silicon, nitric acid, nitrogen trichloride, potassium bromate (explosive), silver bromate, bromine pentafluoride, and more materials. Contact with metal amides can be explosive. Metal carbides and chlorates incandesce in selenium vapor upon heating. Freshly precipitated amorphous selenium can react with water, producing selenous acid and hydrogen.

Conditions to Avoid: Unintended contact in storage areas or reactor vessels.

Hazardous Decomposition Products: Thermal oxidative decomposition of selenium can produce selenium dioxide.

Section 11- Toxicological Information

Toxicity Data:*

Genetic Effects:

Human, blood cultures: selenium (more than any tested selenium compounds) induced sister chromatid exchange.

Tumorigenicity:

Mouse, oral: 480 mg/kg/60 days continuous, resulted in tumors of the skin and appendages (equivocal tumorigenic agent by RTECS criteria).

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Section 11- Toxicological Information, *continued*

Reproductive Effects:
Mouse, oral: 134 mg/kg, over multigenerations resulted in fetotoxicity, and fetal death.

Acute Inhalation Effects:
Rat, inhalation, LC_{Lo}: 33 mg/kg/8 hr resulted in hemorrhage, emphysema, and acute pulmonary edema.

Acute Oral Effects:
Rat, oral, LD_{50}: 6700 mg/kg resulted in somnolence (general depressed activity), dyspnea, other changes in nutrition and gross metabolism.
Mouse, oral, LD_{Lo} 134 mg/kg

* See NIOSH, *RTECS* (VS7700000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: *Scenedesmus*, TLm96=2.5 ppm; *E. Coli*, TLm96=90 ppm. Selenium toxicity occurs frequently among livestock ("alkali disease") of the Great Plains of the US, Canada and Mexico.
Environmental Fate: Selenium undergoes complex chemical and biological cycling through surface water and bottom sediments. It has been found to concentrate in some plants and fish.
Soil Adsorption/Mobility: Elemental selenium is insoluble in water and will have low mobility in the soil column.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Environmentally hazardous substance, solid, n.o.s.*
Shipping Symbols: –
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9
Special Provisions (172.102): 8, B54

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: None
b) Cargo Aircraft Only: None

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: –

*Classified as a hazardous substance when this material is one package which equals or exceeds the CERCLA RQ (see Sec. 15).

Section 15 - Regulatory Information

EPA Regulations:
Classified as a RCRA Hazardous Waste (40 CFR 261.24): Characteristic of Toxicity*
RCRA Hazardous Waste Number: D010
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA Section 307(a)†
CERCLA Final Reportable Quantity (RQ), 100 lb. (45.35 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65 as Selenium compounds)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

*May or may not be characterized as a hazardous waste when subjected to the Toxicant Extraction Procedure (40 CFR 261.24).
†No reporting of release is required if diameter of solid pieces is equal to or exceeds 0.004 inches (100 µm).

Section 16 - Other Information

References: 1, 73, 103, 124, 136, 149, 176, 190, 209, 216, 222, 223, 224, 227, 230

Prepared By..... HM Spliethoff, MS
Industrial Hygiene Review..... DJ Wilson, CIH
Medical Review..... G Kelafant, MD

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PREVIOUS SITE INVESTIGATIONS

TABLE 1
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL VOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE1 (1.5-2)	GPE1 (7-8)	GPE1 (48-49)	GPE2 (1.5-2)	GPE2 (8-9)	GPE2 (47-49)	GPE3 (1.5-2)	GPE3 (4-5)	GPE3 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-001A	0403506-001A	0403681-001A	0402776-001A	0403173-001A	0403173-002A	0402776-002A	0402776-003A	0403169-001A	
Depth(ft):	1.5 - 2	7 - 8	48 - 49	1.5 - 2	8 - 9	47 - 49	1.5 - 2	4 - 5	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/27/2004	3/12/2004	3/15/2004	2/26/2004	3/2/2004	3/3/2004	2/26/2004	2/26/2004	3/2/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Methylene Chloride	0.006 BJ	0.009 BJ	0.012 B	0.005 BJ	0.006 BJ	0.007 BJ	0.007 BJ	0.005 BJ	0.007 BJ	0.1
Acetone	ND @ 0.012	0.15	ND @ 0.011	ND @ 0.011	0.038	ND @ 0.012	0.062	ND @ 0.011	ND @ 0.012	0.2
Carbon Disulfide	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	ND @ 0.012	0.01 J	ND @ 0.011	ND @ 0.012	2.7
2-Butanone	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	ND @ 0.012	0.019	ND @ 0.011	ND @ 0.012	0.3
Benzene	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	ND @ 0.012	0.014	ND @ 0.011	ND @ 0.012	0.06
Toluene	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	ND @ 0.012	0.021	ND @ 0.011	ND @ 0.012	1.5
Ethylbenzene	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	ND @ 0.012	0.38 D	ND @ 0.011	ND @ 0.012	5.5
Total Xylenes	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	ND @ 0.012	0.028	ND @ 0.011	ND @ 0.012	1.2
Styrene	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.012	NSCG
Tetrachloroethene	ND @ 0.012	0.006 J	0.004 J	ND @ 0.011	0.008 BJ	0.007 BJ	ND @ 0.012	ND @ 0.011	0.01 BJ	1.4
Total VOCs	0.006 BJ	0.165 BJ	0.016 BJ	0.005 BJ	0.052 BJ	0.014 BJ	0.541 BJD	0.005 BJ	0.017 BJ	10
Total BTEX	ND	ND	ND	ND	ND	ND	0.443	ND	ND	NSCG
TICs	ND	ND @ 0.012	0.011 BJX	0.021 BNXJ	ND	0.007 BJX	0.0678 J	0.024 BNXJ	ND	NSCG

NOTES:

ND - Indicates Compound Was Not Detected At The Method Detection Limit.
NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

DRAFT

TABLE 1 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL VOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE4 (2-2.5)	GPE4 (9-10)	GPE4 (18-19)	GPE4 (48-49)	GPE5 (1.5-2)	GPE5 (9-10)	GPE5 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403169-002A	0403300-001A	0403300-002A	0403394-002A	0403169-003A	0403394-002A	0403394-003A	
Depth(ft):	2 - 2.5	9 - 10	18 - 19	48 - 49	1.5 - 2	9 - 10	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/1/2004	3/5/2004	3/5/2004	3/8/2004	3/2/2004	3/8/2004	3/9/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Methylene Chloride	0.009 BJ	0.01 BJ	0.009 BJ	0.009 BJ	0.01 BJ	0.007 BJ	0.009 BJ	0.1
Acetone	ND @ 0.011	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	0.049	0.2
Carbon Disulfide	0.002 J	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	2.7
2-Butanone	ND @ 0.011	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	0.3
Benzene	ND @ 0.011	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	0.06
Toluene	ND @ 0.011	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	1.5
Ethylbenzene	ND @ 0.011	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	5.5
Total Xylenes	ND @ 0.011	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	1.2
Styrene	ND @ 0.011	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.012	NSCG
Tetrachloroethene	0.066 B	0.006 BJ	0.005 BJ	0.008 BJ	ND @ 0.011	0.003 J	0.004 J	1.4
Total VOCs	0.077 BJ	0.016	0.014 BJ	0.017 BJ	0.01 BJ	0.01 BJ	0.062 BJ	10
Total BTEX	ND	ND	ND	ND	ND	ND	ND	NSCG
TICS	0.026 NXJ	ND	ND	0.026 BJX	0.029 J	0.012 BJX	0.026 BJX	NSCG

NOTES:
ND - Indicates Compound Was Not Detected At The Method Detection Limit.
NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
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NSCG - Indicates No Soil Cleanup Guidance established.

DRAFT

TABLE 1 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL VOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE6 (1.5-2)	GPE6 (11-12)	GPE6 (16-17)	GPE6 (48-49)	GPE7 (1.5-2)	GPE7 (2.5-3)	GPE7 (8-9)	GPE7 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403169-004A	0403394-004A	0403394-005A	0403394-006A	0403173-003A	0403394-007A	0403394-008A	0403506-002A	
Depth(ft):	1.5 - 2	11 - 12	16 - 17	48 - 49	1.5 - 2	2.5 - 3	8 - 9	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/2/2004	3/9/2004	3/9/2004	3/9/2004	3/2/2004	3/9/2004	3/10/2004	3/11/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Methylene Chloride	0.012 B	0.01 BJ	0.01 BJ	0.008 BJ	0.007 BJ	0.008 BJ	0.008 BJ	0.01 BJ	0.1
Acetone	ND @ 0.012	0.049	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.014	ND @ 0.012	ND @ 0.012	0.2
Carbon Disulfide	ND @ 0.012	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.012	0.002 J	ND @ 0.012	0.002 J	2.7
2-Butanone	ND @ 0.012	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.014	ND @ 0.012	ND @ 0.012	0.3
Benzene	ND @ 0.012	ND @ 0.013	ND @ 0.012	ND @ 0.012	0.2	0.026	ND @ 0.012	ND @ 0.012	0.06
Toluene	ND @ 0.012	ND @ 0.013	ND @ 0.012	ND @ 0.012	1.7 D	0.026	ND @ 0.012	ND @ 0.012	1.5
Ethylbenzene	ND @ 0.012	ND @ 0.013	ND @ 0.012	ND @ 0.012	0.16	0.03	ND @ 0.012	ND @ 0.012	5.5
Total Xylenes	ND @ 0.012	ND @ 0.013	ND @ 0.012	ND @ 0.012	4.7 D	0.21	ND @ 0.012	ND @ 0.012	1.2
Styrene	ND @ 0.012	ND @ 0.013	ND @ 0.012	ND @ 0.012	2 D	0.043	ND @ 0.012	ND @ 0.012	NSCG
Tetrachloroethene	0.093 B	0.007 J	0.007 J	0.003 J	0.071 B	0.01 J	0.006 J	0.009 J	1.4
Total VOCs	0.105 BJ	0.066 BJ	0.017 BJ	0.011 BJ	8.838	0.355 BJ	0.014 BJ	0.021 BJ	10
Total BTEX	ND	ND	ND	ND	6.76 D	0.292	ND	ND	NSCG
TICS	0.029 J	0.027 BJX	0.021 BJX	0.022 BJX	2.091 JZ	0.851 BJX	0.022 BJX	0.011 BJX	NSCG

NOTES:
ND - Indicates Compound Was Not Detected At The Method Detection Limit.
NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 1 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL VOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE8 (1.5-2)	GPE8 (22-23)	GPE8 (48-49)	GPE9 (1.5-2)	GPE9 (12-13)	GPE9 (48-49)	GPE10 (1.5-2)	GPE10 (7-8)	GPE10 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0402776-004A	0403300-003A	0403300-004A	0403085-002A	0403681-002A	0403681-003A	0403085-003A	0403681-004A	0403681-005A	
Depth(ft):	1.5 - 2	22 - 23	48 - 49	1.5 - 2	12 - 13	48 - 49	1.5 - 2	7 - 8	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/26/2004	3/4/2004	3/4/2004	3/1/2004	3/16/2004	3/16/2004	2/27/2004	3/15/2004	3/16/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Methylene Chloride	0.007 BJ	0.008 BJ	0.008 BJ	0.007 BJ	0.013 B	0.013 B	0.007 BJ	0.013 B	0.012 B	0.1
Acetone	ND @ 0.012	ND @ 0.012	ND @ 0.012	0.086	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.013	ND @ 0.012	0.2
Carbon Disulfide	ND @ 0.012	ND @ 0.012	ND @ 0.012	0.2	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.013	ND @ 0.012	2.7
2-Butanone	ND @ 0.012	ND @ 0.012	ND @ 0.012	0.02	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.013	ND @ 0.012	0.3
Benzene	ND @ 0.012	ND @ 0.012	ND @ 0.012	3.3 DY	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.013	ND @ 0.012	0.06
Toluene	ND @ 0.012	ND @ 0.012	ND @ 0.012	4.6 DY	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.013	ND @ 0.012	1.5
Ethylbenzene	ND @ 0.012	ND @ 0.012	ND @ 0.012	1.5 D	ND @ 0.012	ND @ 0.012	0.041	ND @ 0.013	ND @ 0.012	5.5
Total Xylenes	ND @ 0.012	ND @ 0.012	ND @ 0.012	13 DY	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.013	ND @ 0.012	1.2
Styrene	ND @ 0.012	ND @ 0.012	ND @ 0.012	2.1 D	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.013	ND @ 0.012	NSCG
Tetrachloroethene	ND @ 0.012	0.008 BJ	0.002 J	ND @ 0.14	ND @ 0.012	ND @ 0.012	ND @ 0.012	ND @ 0.013	ND @ 0.012	1.4
Total VOCs	0.007 BJ	0.016 BJ	0.01 BJ	24.813 BJDY	0.013 B	0.013 B	0.048 BJ	0.013 B	0.012 B	10
Total BTEX	ND	ND	ND	22.4 DY	ND	ND	ND	ND	ND	NSCG
TICS	0.008 BNXJ	ND	0.028 BJX	0.779 NJ	ND	0.007 BJX	0.084 J	ND	0.012 BJX	NSCG

NOTES:
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D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 1 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL VOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE11 (1.5-2)	GPE11 (9-9.5)	GPE11 (17-18)	GPE11 (48-49)	GPE12 (1.5-2)	GPE12 (19-20)	GPE12 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0402776-005A	0403169-005A	0403169-006A	0403169-007A	0403085-004A	0403506-003A	0403506-004A	
Depth(ft):	1.5 - 2	9 - 9.5	17 - 18	48 - 49	1.5 - 2	19 - 20	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/26/2004	3/3/2004	3/3/2004	3/3/2004	2/27/2004	3/11/2004	3/12/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Methylene Chloride	0.01 BJ	0.009 BJ	0.007 BJ	0.007 BJ	0.008 BJ	0.008 BJ	0.009 BJ	0.1
Acetone	ND @ 0.014	ND @ 0.013	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.012	0.2
Carbon Disulfide	ND @ 0.014	0.009 J	ND @ 0.013	ND @ 0.012	ND @ 0.012	0.002 J	ND @ 0.012	2.7
2-Butanone	ND @ 0.014	ND @ 0.013	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.012	0.3
Benzene	ND @ 0.014	ND @ 0.013	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.012	0.06
Toluene	ND @ 0.014	ND @ 0.013	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.012	1.5
Ethylbenzene	ND @ 0.014	ND @ 0.013	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.012	5.5
Total Xylenes	ND @ 0.014	ND @ 0.013	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.012	1.2
Styrene	ND @ 0.014	ND @ 0.013	ND @ 0.013	ND @ 0.012	ND @ 0.012	ND @ 0.011	ND @ 0.012	NSCG
Tetrachloroethene	ND @ 0.014	0.016 B	0.01 BJ	0.012 B	ND @ 0.012	0.003 J	ND @ 0.012	1.4
Total VOCs	0.01 BJ	0.034 BJ	0.017 BJ	0.019 BJ	0.008 BJ	0.013 BJ	0.009 BJ	10
Total BTEX	ND	ND	ND	ND	ND	ND	ND	NSCG
TICS	0.01 J	0.008 NJ	ND	ND	0.01 BNXJ	0.01 JX	0.049 JX	NSCG

NOTES:
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B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 1 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL VOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE13 (1.5-2)	GPE13 (13-14)	GPE13 (22-23)	GPE13 (48-49)	GPE20 (1.5-2)	GPE22 (48-49)	GPE25 (7-8)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-005A	0403681-006A	0403681-007A	0403681-008A	0402776-006A	0403169-008A	0403506-005A	
Depth(ft):	1.5 - 2	13 - 14	22 - 23	48 - 49	1.5 - 2	48 - 49	7 - 8	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/1/2004	3/17/2004	3/17/2004	3/17/2004	2/26/2004	3/3/2004	3/12/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Methylene Chloride	0.006 BJ	0.02 B	0.012 B	0.01 BJ	0.007 BJ	0.006 BJ	0.01 BJ	0.1
Acetone	ND @ 0.011	ND @ 0.015	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.011	ND @ 0.013	0.2
Carbon Disulfide	ND @ 0.011	ND @ 0.015	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.011	ND @ 0.013	2.7
2-Butanone	ND @ 0.011	ND @ 0.015	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.011	ND @ 0.013	0.3
Benzene	ND @ 0.011	ND @ 0.015	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.011	ND @ 0.013	0.06
Toluene	ND @ 0.011	ND @ 0.015	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.011	ND @ 0.013	1.5
Ethylbenzene	ND @ 0.011	ND @ 0.015	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.011	ND @ 0.013	5.5
Total Xylenes	ND @ 0.011	ND @ 0.015	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.011	ND @ 0.013	1.2
Styrene	ND @ 0.011	ND @ 0.015	ND @ 0.012	ND @ 0.011	ND @ 0.011	ND @ 0.011	ND @ 0.013	NSCG
Tetrachloroethene	ND @ 0.011	0.004 J	0.002 J	ND @ 0.011	ND @ 0.011	0.012 B	0.004 J	1.4
Total VOCs	0.006 BJ	0.024 BJ	0.014 BJ	0.01 BJ	0.007 BJ	0.018 BJ	0.014 BJ	10
Total BTEX	ND	ND	ND	ND	ND	ND	ND	NSCG
TICS	ND	ND	ND	ND	ND	ND	ND	NSCG

NOTES:

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B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.
Soil samples GPE 20, GPE22 and GPE25 are field duplicate samples.

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TABLE 1 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL VOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	FB02262004	FB03032004	FB03122004	TB03082004	TB03122004
Lab Sample ID No:	0402776-007A	0403173-004A	0403506-006A	0403506-007A	0403506-008A
Depth(ft):	0	0	0	0	0
Sample Type:	WATER	WATER	WATER	WATER	WATER
Sample Date:	2/26/2004	3/3/2004	3/12/2004	3/8/2004	3/12/2004
Units:	ug/L	ug/L	ug/L	ug/L	ug/l
Methylene Chloride	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
Acetone	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
Carbon Disulfide	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
2-Butanone	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
Benzene	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
Toluene	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
Ethylbenzene	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
Total Xylenes	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
Styrene	ND @ 10	ND @ 10	ND @ 10	ND @ 10	ND @ 10
Tetrachloroethene	ND @ 10	4 BJ	ND @ 10	ND @ 10	ND @ 10
Total VOCs	ND	4 BJ	ND	ND	ND
Total BTEX	ND	ND	ND	ND	ND
TICS	ND	ND	ND	ND	ND

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TABLE 2
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE1 (1.5-2)	GPE1 (7-8)	GPE1 (48-49)	GPE2 (1.5-2)	GPE2 (8-9)	GPE2 (47-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-001B	0403506-001B	0403681-001B	0402776-001B	0403173-001B	0403173-002A	
Depth(ft):	1.5 - 2	7 - 8	48 - 49	1.5 - 2	8 - 9	47 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/27/2004	3/12/2004	3/15/2004	2/26/2004	3/2/2004	2/26/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Phenol	ND @ 0.39	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	0.03
4-Methylphenol	ND @ 0.39	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	0.9
Isophorone	ND @ 0.39	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	4.4
Naphthalene	0.82	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	13
2-Methylnaphthalene	0.52	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	36.4
Acenaphthylene	1.3	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	41
Acenaphthene	0.15 J	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	50
Dibenzofuran	0.43	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	6.2
Diethylphthalate	ND @ 0.39	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	7.1
Fluorene	0.45	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	50
4,6-Dinitro-2-methyiphenol	ND @ 0.52	ND @ 0.98	ND @ 0.94	ND @ 0.92	0.24 J	ND @ 0.99	50
Phenanthrene	4.5 D	0.092 J	ND @ 0.37	ND @ 0.37	0.16 J	ND @ 0.39	50
Anthracene	0.87	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	50
Carbazole	0.31	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	50
Di-n-butylphthalate	ND @ 0.39	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	8.1
Fluoranthene	5.4 D	ND @ 0.39	ND @ 0.37	ND @ 0.37	0.89	ND @ 0.39	50
Pyrene	8.4 D	0.11 J	ND @ 0.37	ND @ 0.37	0.66	ND @ 0.39	50
Benzo(a)anthracene	3.5 D	ND @ 0.39	ND @ 0.37	ND @ 0.37	0.53	ND @ 0.39	0.224
Chrysene	4.1 D	0.094 J	ND @ 0.37	ND @ 0.37	0.6	ND @ 0.39	0.4
Bis(2-ethylhexyl)phthalate	1.2	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	50
Benzo(b)fluoranthene	5.1 D	ND @ 0.39	ND @ 0.37	ND @ 0.37	0.42	ND @ 0.39	1.1
Benzo(k)fluoranthene	2	ND @ 0.39	ND @ 0.37	ND @ 0.37	0.43	ND @ 0.39	1.1
Benzo(a)pyrene	3.1	0.092 J	ND @ 0.37	ND @ 0.37	0.28 J	ND @ 0.39	0.061
Indeno(1,2,3-cd)pyrene	1.8	ND @ 0.39	ND @ 0.37	ND @ 0.37	0.22 J	ND @ 0.39	3.2
Dibenzo(a,h)anthracene	0.71	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.4	ND @ 0.39	0.014
Benzo(g,h,I)perylene	2.2	ND @ 0.39	ND @ 0.37	ND @ 0.37	0.19 J	ND @ 0.39	50
Total SVOCs	46.86 JD	0.388 J	ND	ND	4.62 J	ND	500
Total PAHs	44.92 JD	0.388 J	ND	ND	4.38 J	ND	NSCG
Total CaPAHs	20.31 D	0.186 J	ND	ND	2.67 J	ND	NSCG
TICS	22.59 NJA	10.2 NJA	35.87 NJAX	16.47 NJA	88.12 NJA	11.29 NJA	NSCG

NOTES:

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NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 2 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE3 (1.5-2)	GPE3 (4-5)	GPE3 (48-49)	GPE4 (2-2.5)	GPE4 (9-10)	GPE4 (18-19)	GPE4 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0402776-002B	0402776-003B	0403169-001B	0403169-002B	0403300-001B	0403300-002B	0403394-002B	
Depth(ft):	1.5 - 2	4 - 5	48 - 49	2 - 2.5	9 - 10	18 - 19	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/26/2004	2/26/2004	3/2/2004	3/1/2004	3/5/2004	3/5/2004	3/8/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Phenol	ND @ 10	ND @ 0.37	ND @ 0.4	ND @ 0.38	ND @ 0.4	ND @ 0.39	ND @ 0.4	0.03
4-Methylphenol	ND @ 10	ND @ 0.37	ND @ 0.4	0.83 J	ND @ 0.4	ND @ 0.39	ND @ 0.4	0.9
Isophorone	ND @ 10	ND @ 0.37	ND @ 0.4	ND @ 0.38	ND @ 0.4	ND @ 0.39	ND @ 0.4	4.4
Naphthalene	17	0.22 J	ND @ 0.4	1.9	ND @ 0.4	ND @ 0.39	ND @ 0.4	13
2-Methylnaphthalene	7.4	0.09 J	ND @ 0.4	1.1	ND @ 0.4	ND @ 0.39	ND @ 0.4	36.4
Acenaphthylene	15	0.16 J	ND @ 0.4	3	ND @ 0.4	ND @ 0.39	ND @ 0.4	41
Acenaphthene	6.4 J	ND @ 0.37	ND @ 0.4	0.38	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
Dibenzofuran	3.8 J	ND @ 0.37	ND @ 0.4	0.56	ND @ 0.4	ND @ 0.39	ND @ 0.4	6.2
Diethylphthalate	ND @ 10	0.13 J	0.44	0.18 J	ND @ 0.4	ND @ 0.39	ND @ 0.4	7.1
Fluorene	22	0.12 J	ND @ 0.4	1.5	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
4,6-Dinitro-2-methylphenol	ND @ 26	ND @ 0.93	ND @ 1	ND @ 0.95	ND @ 1	ND @ 0.98	ND @ 1	50
Phenanthrene	72	0.53	ND @ 0.4	10 D	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
Anthracene	20	0.12 J	ND @ 0.4	2.2	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
Carbazole	ND @ 10	ND @ 0.37	ND @ 0.4	0.37 J	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
Di-n-butylphthalate	ND @ 10	ND @ 0.37	ND @ 0.4	ND @ 0.38	ND @ 0.4	ND @ 0.39	ND @ 0.4	8.1
Fluoranthene	39	0.49	ND @ 0.4	13 D	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
Pyrene	83	0.79	ND @ 0.4	19 D	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
Benzo(a)anthracene	33	0.37	ND @ 0.4	8.6 D	ND @ 0.4	ND @ 0.39	ND @ 0.4	0.224
Chrysene	40	0.42	ND @ 0.4	10 D	ND @ 0.4	ND @ 0.39	ND @ 0.4	0.4
Bis(2-ethylhexyl)phthalate	ND @ 10	ND @ 0.37	ND @ 0.4	0.81	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
Benzo(b)fluoranthene	42	0.43	ND @ 0.4	14 D	ND @ 0.4	ND @ 0.39	ND @ 0.4	1.1
Benzo(k)fluoranthene	21	0.2 J	ND @ 0.4	4.1	ND @ 0.4	ND @ 0.39	ND @ 0.4	1.1
Benzo(a)pyrene	33	0.43	ND @ 0.4	9.8 D	ND @ 0.4	ND @ 0.39	ND @ 0.4	0.061
Indeno(1,2,3-cd)pyrene	9.2 J	0.14 J	ND @ 0.4	3	ND @ 0.4	ND @ 0.39	ND @ 0.4	3.2
Dibenzo(a,h)anthracene	4.3 J	ND @ 0.37	ND @ 0.4	1.2	ND @ 0.4	ND @ 0.39	ND @ 0.4	0.014
Benzo(g,h,I)perylene	10	0.17	ND @ 0.4	3.4	ND @ 0.4	ND @ 0.39	ND @ 0.4	50
Total SVOCs	478.10 J	4.81 J	0.44	109.13 JD	ND	ND	ND	500
Total PAHs	474.30 J	4.68 J	ND	106.38 D	ND	ND	ND	NSCG
Total CaPAHs	182.50 J	1.99 J	ND	50.9 D	ND	ND	ND	NSCG
TICS	796 NJ	25.76 NJA	8.8 NJA	52.93 NJA	37.6 NJA	53.5 NJA	5.14 NJA	NSCG

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N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 2 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE5 (1.5-2)	GPE5 (9-10)	GPE5 (48-49)	GPE6 (1.5-2)	GPE6 (11-12)	GPE6 (16-17)	GPE6 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403169-003B	0403394-002B	0403394-003B	0403169-004B	0403394-004B	0403394-005B	0403394-006B	
Depth(ft):	1.5 - 2	9 - 10	48 - 49	1.5 - 2	11 - 12	16 - 17	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/2/2004	3/8/2004	3/9/2004	3/2/2004	3/9/2004	3/9/2004	3/9/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Phenol	ND @ 7.3	ND @ 0.37	ND @ 0.41	ND @ 0.41	ND @ 0.44	ND @ 0.41	ND @ 0.39	0.03
4-Methylphenol	ND @ 7.3	ND @ 0.37	ND @ 0.41	ND @ 0.41	ND @ 0.44	ND @ 0.41	ND @ 0.39	0.9
Isophorone	ND @ 7.3	ND @ 0.37	ND @ 0.41	ND @ 0.41	ND @ 0.44	ND @ 0.41	ND @ 0.39	4.4
Naphthalene	2.9 J	0.27 J	ND @ 0.41	0.3 J	0.11 J	ND @ 0.41	ND @ 0.39	13
2-Methylnaphthalene	2.3 J	0.18 J	ND @ 0.41	0.16 J	0.18 J	ND @ 0.41	ND @ 0.39	36.4
Acenaphthylene	3.2 J	0.59	ND @ 0.41	0.4 J	0.12 J	ND @ 0.41	ND @ 0.39	41
Acenaphthene	ND @ 7.3	ND @ 0.37	ND @ 0.41	ND @ 0.41	ND @ 0.44	ND @ 0.41	ND @ 0.39	50
Dibenzofuran	ND @ 7.3	ND @ 0.37	ND @ 0.41	ND @ 0.41	ND @ 0.44	ND @ 0.41	ND @ 0.39	6.2
Diethylphthalate	ND @ 7.3	ND @ 0.37	ND @ 0.41	ND @ 0.41	0.2 J	ND @ 0.41	0.93 J	7.1
Fluorene	1.5 J	0.76 J	ND @ 0.41	0.12 J	ND @ 0.44	ND @ 0.41	ND @ 0.39	50
4,6-Dinitro-2-methylphenol	ND @ 18	ND @ 0.92	ND @ 1	ND @ 1	ND @ 1.1	ND @ 1	ND @ 0.98	50
Phenanthrene	12	0.79	ND @ 0.41	1.2	0.35 J	ND @ 0.41	ND @ 0.39	50
Anthracene	2.1 J	0.26 J	ND @ 0.41	0.26 J	ND @ 0.44	ND @ 0.41	ND @ 0.39	50
Carbazole	ND @ 7.3	ND @ 0.37	ND @ 0.41	N	ND @ 0.44	ND @ 0.41	ND @ 0.39	50
Di-n-butylphthalate	ND @ 7.3	ND @ 0.37	ND @ 0.41	0.085 J	ND @ 0.44	ND @ 0.41	ND @ 0.39	8.1
Fluoranthene	12	1.5	ND @ 0.41	1.1	0.35 J	0.19 J	ND @ 0.39	50
Pyrene	25	2.5	ND @ 0.41	1.8	0.66 J	0.11 J	ND @ 0.39	50
Benzo(a)anthracene	6.7	13	ND @ 0.41	0.08	0.26 J	ND @ 0.41	ND @ 0.39	0.224
Chrysene	9.9	1.5	ND @ 0.41	1	0.28 J	ND @ 0.41	ND @ 0.39	0.4
Bis(2-ethylhexyl)phthalate	ND @ 7.3	0.21 J	ND @ 0.41	0.13 J	ND @ 0.44	ND @ 0.41	ND @ 0.39	50
Benzo(b)fluoranthene	13	0.75	ND @ 0.41	1.2	ND @ 0.44	ND @ 0.41	ND @ 0.39	1.1
Benzo(k)fluoranthene	5 J	0.86	ND @ 0.41	0.49	ND @ 0.44	ND @ 0.41	ND @ 0.39	1.1
Benzo(a)pyrene	10	12	ND @ 0.41	0.85	0.24 J	ND @ 0.41	ND @ 0.39	0.061
Indeno(1,2,3-cd)pyrene	2.7 J	0.67	ND @ 0.41	0.27 J	0.13 J	ND @ 0.41	ND @ 0.39	3.2
Dibenzo(a,h)anthracene	ND @ 7.3	ND @ 0.37	ND @ 0.41	0.1 J	ND @ 0.44	ND @ 0.41	ND @ 0.39	0.014
Benzo(g,h,I)perylene	3.3 J	0.82	ND @ 0.41	0.32 J	0.19 J	ND @ 0.41	ND @ 0.39	50
Total SVOCs	113.6 J	14.16 J	ND	10.665 J	3.07 J	0.3 J	0.93 J	500
Total PAHs	113.6 J	13.95 J	ND	10.45 J	2.87 J	0.3 J	ND	NSCG
Total CaPAHs	49.3 J	6.28 J	ND	4.79 J	0.91 J	ND	ND	NSCG
TICS	60 NJA	72.03 NJA	25.8 NJA	13.98 NJA	72.82 NJA	15.93 NJA	13.2 NJA	NSCG

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NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates that No Soil Cleanup Guidance established.

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TABLE 2 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE7 (1.5-2)	GPE7 (2.5-3)	GPE7 (8-9)	GPE7 (48-49)	GPE8 (1.5-2)	GPE8 (22-23)	GPE8 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403173-003B	0403394-007B	0403394-008B	0403506-002B	0402776-004B	0403300-003B	0403300-004B	
Depth(ft):	1.5 - 2	2.5 - 3	8 - 9	48 - 49	1.5 - 2	22 - 23	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/2/2004	3/9/2004	3/10/2004	3/11/2004	2/26/2004	3/4/2004	3/4/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Phenol	ND @ 81	ND @ 23	ND @ 0.4	ND @ 0.38	ND @ 0.39	ND @ 0.39	ND @ 0.38	0.03
4-Methylphenol	ND @ 81	ND @ 23	ND @ 0.4	ND @ 0.38	ND @ 0.39	ND @ 0.39	ND @ 0.38	0.9
Isophorone	ND @ 81	ND @ 23	ND @ 0.4	ND @ 0.38	ND @ 0.39	ND @ 0.39	ND @ 0.38	4.4
Naphthalene	140	51	0.6	ND @ 0.38	0.7	0.086 J	ND @ 0.38	13
2-Methylnaphthalene	220	63	0.21 J	ND @ 0.38	0.41	ND @ 0.39	ND @ 0.38	36.4
Acenaphthylene	85	12 J	0.14 J	ND @ 0.38	1.1	ND @ 0.39	ND @ 0.38	41
Acenaphthene	18 J	ND @ 23	0.34 J	ND @ 0.38	0.085 J	ND @ 0.39	ND @ 0.38	50
Dibenzofuran	ND @ 81	ND @ 23	0.16 J	ND @ 0.38	0.23 J	ND @ 0.39	ND @ 0.38	6.2
Diethylphthalate	ND @ 81	ND @ 23	ND @ 0.4	ND @ 0.38	ND @ 0.39	ND @ 0.39	ND @ 0.38	7.1
Fluorene	94	21 J	0.32 J	ND @ 0.38	0.46	ND @ 0.39	ND @ 0.38	50
4,6-Dinitro-2-methylphenol	ND @ 200	ND @ 58	ND @ 1	ND @ 0.96	ND @ 0.97	ND @ 0.98	ND @ 0.38	50
Phenanthrene	340	57 J	1.4	ND @ 0.38	4.6	ND @ 0.39	ND @ 0.38	50
Anthracene	74 J	13 J	0.51	ND @ 0.38	0.74	ND @ 0.39	ND @ 0.38	50
Carbazole	ND @ 81	ND @ 23	0.15 J	ND @ 0.38	0.27 J	ND @ 0.39	ND @ 0.38	50
Di-n-butylphthalate	ND @ 81	ND @ 23	ND @ 0.4	ND @ 0.38	ND @ 0.39	ND @ 0.39	ND @ 0.38	8.1
Fluoranthene	180	36	2	ND @ 0.38	4.8	ND @ 0.39	ND @ 0.38	50
Pyrene	330	95	2.1	ND @ 0.38	6.8 D	ND @ 0.39	ND @ 0.38	50
Benzo(a)anthracene	120	21 J	0.99	ND @ 0.38	2.9	ND @ 0.39	ND @ 0.38	0.224
Chrysene	140	22 J	1.1	ND @ 0.38	3.1	ND @ 0.39	ND @ 0.38	0.4
Bis(2-ethylhexyl)phthalate	ND @ 81	ND @ 23	ND @ 0.4	ND @ 0.38	0.14	ND @ 0.39	ND @ 0.38	50
Benzo(b)fluoranthene	51 J	14 J	0.6	ND @ 0.38	3.9	ND @ 0.39	ND @ 0.38	1.1
Benzo(k)fluoranthene	84	17 J	0.79	ND @ 0.38	1.9	ND @ 0.39	ND @ 0.38	1.1
Benzo(a)pyrene	110	19 J	0.79	ND @ 0.38	2.9	ND @ 0.39	ND @ 0.38	0.061
Indeno(1,2,3-cd)pyrene	47 J	9.4 J	0.53	ND @ 0.38	0.997	ND @ 0.39	ND @ 0.38	3.2
Dibenzo(a,h)anthracene	ND @ 81	ND @ 23	ND @ 0.4	ND @ 0.38	0.32 J	ND @ 0.39	ND @ 0.38	0.014
Benzo(g,h,I)perylene	63 J	14 J	0.59	ND @ 0.38	1	ND @ 0.39	ND @ 0.38	50
Total SVOCs	2096 J	461.40 J	23.32 J	ND	37.352 J	0.086 J	ND	500
Total PAHs	2096 J	461.40 J	13.01 J	ND	36.712 J	0.086 J	ND	NSCG
Total CaPAHs	552 J	99.40 J	4.8	ND	16.017 J	ND	ND	NSCG
TICS	2062 NJ	1120 NJ	163.72	18.01 NJA	41.61 NJA	30.74 NJA	10.6 NJA	NSCG

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NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 2 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE9 (1.5-2)	GPE9 (12-13)	GPE9 (48-49)	GPE10 (1.5-2)	GPE10 (7-8)	GPE10 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-002B	0403681-002B	0403681-003B	0403085-003B	0403681-004B	0403681-005B	
Depth(ft):	1.5 - 2	12 - 13	48 - 49	1.5 - 2	7 - 8	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/1/2004	3/16/2004	3/16/2004	2/27/2004	3/15/2004	3/16/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Phenol	ND @ 48	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	0.03
4-Methylphenol	ND @ 48	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	0.9
Isophorone	ND @ 48	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	4.4
Naphthalene	1700 D	ND @ 0.41	ND @ 0.4	6.3	ND @ 0.43	ND @ 0.38	13
2-Methylnaphthalene	1000 D	ND @ 0.41	ND @ 0.4	2.8 J	ND @ 0.43	ND @ 0.38	36.4
Acenaphthylene	170	ND @ 0.41	ND @ 0.4	3.2 J	ND @ 0.43	ND @ 0.38	41
Acenaphthene	33	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	50
Dibenzofuran	43	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	6.2
Diethylphthalate	ND @ 48	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	7.1
Fluorene	240	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	50
4,6-Dinitro-2-methylphenol	ND @ 120	ND @ 1	ND @ 1	ND @ 20	ND @ 1.1	ND @ 0.96	50
Phenanthrene	870 D	ND @ 0.41	ND @ 0.4	7.8	ND @ 0.43	ND @ 0.38	50
Anthracene	180	ND @ 0.41	ND @ 0.4	1.9 J	ND @ 0.43	ND @ 0.38	50
Carbazole	ND @ 48	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	50
Di-n-butylphthalate	ND @ 48	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	8.1
Fluoranthene	260	ND @ 0.41	ND @ 0.4	7.9	ND @ 0.43	ND @ 0.38	50
Pyrene	510 D	ND @ 0.41	ND @ 0.4	14	ND @ 0.43	ND @ 0.38	50
Benzo(a)anthracene	210	ND @ 0.41	ND @ 0.4	7.3 J	ND @ 0.43	ND @ 0.38	0.224
Chrysene	200	ND @ 0.41	ND @ 0.4	10	ND @ 0.43	ND @ 0.38	0.4
Bis(2-ethylhexyl)phthalate	ND @ 48	ND @ 0.41	ND @ 0.4	ND @ 8.1	ND @ 0.43	ND @ 0.38	50
Benzo(b)fluoranthene	170	ND @ 0.41	ND @ 0.4	11	ND @ 0.43	ND @ 0.38	1.1
Benzo(k)fluoranthene	62	ND @ 0.41	ND @ 0.4	4.5	ND @ 0.43	ND @ 0.38	1.1
Benzo(a)pyrene	150	ND @ 0.41	ND @ 0.4	6.2	ND @ 0.43	ND @ 0.38	0.061
Indeno(1,2,3-cd)pyrene	44	ND @ 0.41	ND @ 0.4	3.6 J	ND @ 0.43	ND @ 0.38	3.2
Dibenzo(a,h)anthracene	20 J	ND @ 0.41	ND @ 0.4	1.3 J	ND @ 0.43	ND @ 0.38	0.014
Benzo(g,h,I)perylene	57	ND @ 0.41	ND @ 0.4	3.9 J	ND @ 0.43	ND @ 0.38	50
Total SVOCs	5919 JD	ND	ND	91.6 J	ND	ND	500
Total PAHs	5876 JD	ND	ND	91.6 J	ND	ND	NSCG
Total CaPAHs	856 J	ND	ND	43.8 J	ND	ND	NSCG
TICS	3503 NJ	28.48 NJAX	36.2 NJAX	179.5 J	38.58 NJAX	30.19 NJAX	NSCG

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NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 2 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE11 (1.5-2)	GPE11 (9-9.5)	GPE11 (17-18)	GPE11 (48-49)	GPE12 (1.5-2)	GPE12 (19-20)	GPE12 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0402776-005B	0403169-005B	0403169-006B	0403169-007B	0403085-004B	0403506-003B	0403506-004B	
Depth(ft):	1.5 - 2	9 - 9.5	17 - 18	48 - 49	1.5 - 2	19 - 20	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/26/2004	3/3/2004	3/3/2004	3/3/2004	2/27/2004	3/11/2004	3/12/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Phenol	ND @ 9.3	ND @ 0.43	ND @ 0.41	ND @ 0.39	ND @ 0.39	ND @ 0.38	ND @ 0.39	0.03
4-Methylphenol	ND @ 9.3	ND @ 0.43	ND @ 0.41	ND @ 0.39	ND @ 0.39	ND @ 0.38	ND @ 0.39	0.9
Isophorone	ND @ 9.3	ND @ 0.43	0.11 J	ND @ 0.39	ND @ 0.39	ND @ 0.38	ND @ 0.39	4.4
Naphthalene	5.3 J	1.2	0.17 J	0.13 J	0.65	ND @ 0.38	0.27	13
2-Methylnaphthalene	ND @ 9.3	0.46	ND @ 0.41	ND @ 0.39	0.42	ND @ 0.38	0.23	36.4
Acenaphthylene	ND @ 9.3	0.4 J	ND @ 0.41	ND @ 0.39	0.88	ND @ 0.38	ND @ 0.39	41
Acenaphthene	1.9 J	0.25 J	ND @ 0.41	ND @ 0.39	0.075 J	ND @ 0.38	ND @ 0.39	50
Dibenzofuran	ND @ 9.3	0.1 J	ND @ 0.41	ND @ 0.39	0.11 J	ND @ 0.38	ND @ 0.39	6.2
Diethylphthalate	ND @ 9.3	ND @ 0.43	0.12 J	ND @ 0.39	ND @ 0.39	ND @ 0.38	ND @ 0.39	7.1
Fluorene	2.4 J	0.56	ND @ 0.41	ND @ 0.39	0.25	ND @ 0.38	ND @ 0.39	50
4,6-Dinitro-2-methylphenol	ND @ 24	ND @ 1.1	ND @ 1	ND @ 0.99	ND @ 0.98	ND @ 0.94	ND @ 0.98	50
Phenanthrene	25	1.1	0.37 J	ND @ 0.39	2.5	ND @ 0.38	0.094 J	50
Anthracene	4.4 J	0	ND @ 0.41	ND @ 0.39	0.52	ND @ 0.38	ND @ 0.39	50
Carbazole	1.9 J	0.62	ND @ 0.41	ND @ 0.39	0.13 J	ND @ 0.38	ND @ 0.39	50
Di-n-butylphthalate	ND @ 9.3	ND @ 0.43	ND @ 0.41	ND @ 0.39	ND @ 0.39	ND @ 0.38	ND @ 0.39	8.1
Fluoranthene	45	4	0.31 J	ND @ 0.39	2.9	ND @ 0.38	ND @ 0.39	50
Pyrene	32	9.3 D	0.43	ND @ 0.39	7 D	ND @ 0.38	ND @ 0.39	50
Benzo(a)anthracene	22	2.3	0.16 J	ND @ 0.39	2.6	ND @ 0.38	ND @ 0.39	0.224
Chrysene	23	2.8	0.22 J	ND @ 0.39	3	ND @ 0.38	ND @ 0.39	0.4
Bis(2-ethylhexyl)phthalate	ND @ 9.3	ND @ 0.43	0.26 J	ND @ 0.39	0.55	ND @ 0.38	ND @ 0.39	50
Benzo(b)fluoranthene	23	2.3	ND @ 0.41	ND @ 0.39	5.1 D	ND @ 0.38	ND @ 0.39	1.1
Benzo(k)fluoranthene	8.13	0.73	ND @ 0.41	ND @ 0.39	1.7	ND @ 0.38	ND @ 0.39	1.1
Benzo(a)pyrene	14	1.5	0.11 J	ND @ 0.39	3.5 D	ND @ 0.38	ND @ 0.39	0.061
Indeno(1,2,3-cd)pyrene	7.6 J	0.45	ND @ 0.41	ND @ 0.39	1.6	ND @ 0.38	ND @ 0.39	3.2
Dibenzo(a,h)anthracene	2.6 J	0.2 J	ND @ 0.41	ND @ 0.39	0.49	ND @ 0.38	ND @ 0.39	0.014
Benzo(g,h,i)perylene	6.5 J	0.51	ND @ 0.41	ND @ 0.39	2.1	ND @ 0.38	ND @ 0.39	50
Total SVOCs	229.6 J	28.88 J	2.26 J	0.13 J	36.075 JD	ND	0.594 J	500
Total PAHs	227.7 J	28.78 J	1.77 J	0.13 J	35.285 JD	ND	0.594 J	NSCG
Total CaPAHs	105.2 J	10.38 J	0.49 J	ND	17.99 D	ND	ND	NSCG
TICS	785.6 NJAX	54.94 NJA	21.62 NJA	4.91 NJA	21.03 NJA	5.74 NJA	6.3 NJA	NSCG

NOTES:

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NA - Indicates Sample Was Not Analyzed For That Parameter.
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J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 2 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	GPE13 (1.5-2)	GPE13 (13-14)	GPE13 (22-23)	GPE13 (48-49)	GPE20 (1.5-2)	GPE22 (48-49)	GPE25 (7-8)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-005B	0403681-006B	0403681-007B	0403681-008B	0402776-006B	0403169-008B	0403506-005B	
Depth(ft):	1.5 - 2	13 - 14	22 - 23	48 - 49	1.5 - 2	48 - 49	7 - 8	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/1/2004	3/17/2004	3/17/2004	3/17/2004	2/26/2004	3/3/2004	3/12/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Phenol	ND @ 0.35	ND @ 0.49	ND @ 0.39	ND @ 0.37	0.1 J	ND @ 0.37	ND @ 0.42	0.03
4-Methylphenol	ND @ 0.35	ND @ 0.49	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.37	0.12 J	0.9
Isophorone	ND @ 0.35	ND @ 0.49	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.37	ND @ 0.42	4.4
Naphthalene	0.27	0.3 J	0.33 J	ND @ 0.37	0.3 J	ND @ 0.37	0.83	13
2-Methylnaphthalene	0.087 J	ND @ 0.49	0.12 J	ND @ 0.37	0.22 J	ND @ 0.37	0.37 J	36.4
Acenaphthylene	0.096 J	0.12 J	ND @ 0.39	ND @ 0.37	0.78	ND @ 0.37	0.14 J	41
Acenaphthene	0.051 J	0.17 J	0.12 J	ND @ 0.37	ND @ 0.37	ND @ 0.37	0.45	50
Dibenzofuran	0.05 J	0.12 J	0.31 J	ND @ 0.37	ND @ 0.37	ND @ 0.37	0.38 J	6.2
Diethylphthalate	ND @ 0.35	ND @ 0.49	ND @ 0.39	ND @ 0.37	ND @ 0.37	0.14 J	ND @ 0.42	7.1
Fluorene	0.092 J	0.18 J	0.27 J	ND @ 0.37	0.18 J	ND @ 0.37	0.44	50
4,6-Dinitro-2-methylphenol	ND @ 0.88	ND @ 1.2	ND @ 0.98	ND @ 0.93	ND @ 0.94	ND @ 0.92	ND @ 1.1	50
Phenanthrene	0.7	2.4	1.5	ND @ 0.37	2.3	ND @ 0.37	3.5	50
Anthracene	0.13 J	0.59	0.31 J	ND @ 0.37	0.37	ND @ 0.37	0.65	50
Carbazole	0.06 J	0.22 J	0.2 J	ND @ 0.37	ND @ 0.37	ND @ 0.37	0.37 J	50
Di-n-butylphthalate	ND @ 0.35	ND @ 0.49	ND @ 0.39	ND @ 0.37	ND @ 0.37	ND @ 0.37	ND @ 0.42	8.1
Fluoranthene	0.89	3.5	1	ND @ 0.37	2.6	ND @ 0.37	2.7	50
Pyrene	0.89	3.5	0.86	ND @ 0.37	5.2	ND @ 0.37	2.7	50
Benzo(a)anthracene	0.51	1.7	0.21 J	ND @ 0.37	2	ND @ 0.37	1.2	0.224
Chrysene	0.53	2.3	0.29 J	ND @ 0.37	2.2	ND @ 0.37	1.5	0.4
Bis(2-ethylhexyl)phthalate	ND @ 0.35	ND @ 0.49	ND @ 0.39	ND @ 0.37	0.12 J	ND @ 0.37	0.12 J	50
Benzo(b)fluoranthene	0.54	1.5	ND @ 0.39	ND @ 0.37	3	ND @ 0.37	0.87	1.1
Benzo(k)fluoranthene	0.27	1.8	ND @ 0.39	ND @ 0.37	0.89	ND @ 0.37	1	1.1
Benzo(a)pyrene	0.49	1.9	0.16 J	ND @ 0.37	2.1	ND @ 0.37	0.98	0.061
Indeno(1,2,3-cd)pyrene	0.23	1.3	0.11 J	ND @ 0.37	0.77	ND @ 0.37	0.65	3.2
Dibenzo(a,h)anthracene	0.078 J	ND @ 0.49	ND @ 0.39	ND @ 0.37	0.3 J	ND @ 0.37	0.32 J	0.014
Benzo(g,h,I)perylene	0.22	1.5	0.13 J	ND @ 0.37	0.92	ND @ 0.37	0.76	50
Total SVOCs	6.184 J	23.1 J	5.92 J	ND	24.35 J	0.14 J	20.03 J	500
Total PAHs	6.074 J	22.76 J	5.41 J	ND	24.13 J	ND	19.04 J	NSCG
Total CaPAHs	2.648 J	10.5	1.34 J	ND	11.26 J	ND	6.5 J	NSCG
TICS	8.341 BNJXA	54.61 NJAX	32.53 NJAX	32.9 NJAX	29.39 NJAX	6.8 NJA	17.69 NJA	NSCG

NOTES:

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B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.
Soil samples GPE20, GPE22 and GPE25 are field duplicate samples.

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TABLE 2 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
TCL SEMIVOLATILE ORGANIC COMPOUNDS IN SOIL
MARCH 2004

Sample Number:	FB02262004	FB03032004	FB03122004
Lab Sample ID No:	0402776-007B	0403173-004B	0403506-006B
Depth(ft):	0	0	0
Sample Type:	WATER	WATER	WATER
Sample Date:	2/26/2004	3/3/2004	3/12/2004
Units:	ug/L	ug/L	ug/L
Phenol	ND @ 10	ND @ 10	ND @ 10
4-Methylphenol	ND @ 10	ND @ 10	ND @ 10
Isophorone	ND @ 10	ND @ 10	ND @ 10
Naphthalene	ND @ 10	ND @ 10	ND @ 10
2-Methylnaphthalene	ND @ 10	ND @ 10	ND @ 10
Acenaphthylene	ND @ 10	ND @ 10	ND @ 10
Acenaphthene	ND @ 10	ND @ 10	ND @ 10
Dibenzofuran	ND @ 10	ND @ 10	ND @ 10
Diethylphthalate	ND @ 10	ND @ 10	2 J
Fluorene	ND @ 10	ND @ 10	ND @ 10
4,6-Dinitro-2-methylphenol	ND @ 25	ND @ 25	ND @ 25
Phenanthrene	ND @ 10	ND @ 10	ND @ 10
Anthracene	ND @ 10	ND @ 10	ND @ 10
Carbazole	ND @ 10	ND @ 10	ND @ 10
Di-n-butylphthalate	ND @ 10	ND @ 10	ND @ 10
Fluoranthene	ND @ 10	ND @ 10	ND @ 10
Pyrene	ND @ 10	ND @ 10	ND @ 10
Benzo(a)anthracene	ND @ 10	ND @ 10	ND @ 10
Chrysene	ND @ 10	ND @ 10	ND @ 10
Bis(2-ethylhexyl)phthalate	ND @ 10	ND @ 10	ND @ 10
Benzo(b)fluoranthene	ND @ 10	ND @ 10	ND @ 10
Benzo(k)fluoranthene	ND @ 10	ND @ 10	ND @ 10
Benzo(a)pyrene	ND @ 10	ND @ 10	ND @ 10
Indeno(1,2,3-cd)pyrene	ND @ 10	ND @ 10	ND @ 10
Dibenzo(a,h)anthracene	ND @ 10	ND @ 10	ND @ 10
Benzo(g,h,I)perylene	ND @ 10	ND @ 10	ND @ 10
Total SVOCs	ND	ND	2 J
Total PAHs	ND	ND	ND
Total CaPAHs	ND	ND	ND
TICS	ND	11 J	ND

NOTES:
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N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.

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TABLE 3
GREENPOINT FORMER MGP SITE INVESTIGATION
RCRA METALS AND TOTAL CYANIDE IN SOIL
MARCH 2004

Sample Number:	GPE1 (1.5-2)	GPE1 (7-8)	GPE1 (48-49)	GPE2 (1.5-2)	GPE2 (8-9)	GPE2 (47-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-001	0403506-004	0403681-001	0402776-001	0403173-001	0403173-002	
Depth(ft):	1.5 - 2	7 - 8	48 - 49	1.5 - 2	8 - 9	47 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/27/2004	3/12/2004	3/15/2004	2/26/2004	3/2/2004	3/3/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Arsenic	10.2	46.3	7.1	5.8	3.4	1 B	7.5
Barium	144	55.5	46.3	49	80.6	51.9	300
Cadmium	0.39 B	0.12 B	ND @ 0.023	ND @ 0.022	0.22 B	0.11 B	1
Chromium	16.3	29.6	22.6	8.6	41.2	7.8	10
Total Cyanide	11.6	4.5	ND @ 0.57	11.8	0.66	ND @ 0.59	NSCG
Lead	134	50.7	5.3	6	8.1	2.5	NSCG
Mercury	2.8	0.049	ND @ 0.019	0.049	ND @ 0.02	ND @ 0.02	0.1
Selenium	1.8	1.1	ND @ 0.20	0.83	ND @ 0.22	ND @ 0.21	2
Silver	1.4	0.16 B	0.11 B	0.045	ND @ 0.061	0.062 B	NSCG

NOTES:

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NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 3 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
RCRA METALS AND TOTAL CYANIDE IN SOIL
MARCH 2004

Sample Number:	GPE3 (1.5-2)	GPE3 (4-5)	GPE3 (48-49)	GPE4 (2-2.5)	GPE4 (9-10)	GPE4 (18-19)	GPE4 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0402776-002	0402776-003	0403169-001	0403169-002	0403300-001	0403300-002	0403394-002	
Depth(ft):	1.5 - 2	4 - 5	48 - 49	2 - 2.5	9 - 10	18 - 19	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/26/2004	2/26/2004	3/2/2004	3/1/2004	3/5/2004	3/5/2004	3/8/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Arsenic	22.3	5.7	0.75 B	23.3	2.3	3.2	ND @ 0.26	7.5
Barium	200	50.7	21 B	259	16.6 B	59.6	15.6 B	300
Cadmium	0.97	ND @ 0.022	ND @ 0.024	2	0.1 B	0.21 B	0.088 B	1
Chromium	18.3	21.3	6.8	47.6	4.2	9.9	5.1	10
Total Cyanide	220 B	21.3	ND @ 0.61	14.9	ND @ 0.6	ND @ 0.59	ND @ 0.5	NSCG
Lead	356	13.4	2.9	344	1.3	1.3	1.2	NSCG
Mercury	6.4 B	0.069	ND @ 0.024	1.4	ND @ 0.02	ND @ 0.02	ND @ 0.02	0.1
Selenium	2.2	1.1	0.37 B	2.7	ND @ 0.22	ND @ 0.21	ND @ 0.22	2
Silver	0.91	ND @ 0.045	ND @ 0.048	0.71 B	ND @ 0.06	0.13 B	ND @ 0.061	NSCG

NOTES:

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NA - Indicates Sample Was Not Analyzed For That Parameter.
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J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
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NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 3 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
RCRA METALS AND TOTAL CYANIDE IN SOIL
MARCH 2004

Sample Number:	GPE5 (1.5-2)	GPE5 (9-10)	GPE5 (48-49)	GPE6 (1.5-2)	GPE6 (11-12)	GPE6 (16-17)	GPE6 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403169-003	0403394-002	0403394-003	0403169-004	0403394-004	0403394-005	0403394-006	
Depth(ft):	1.5 - 2	9 - 10	48 - 49	1.5 - 2	11 - 12	16 - 17	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/2/2004	3/8/2004	3/9/2004	3/2/2004	3/9/2004	3/9/2004	3/9/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Arsenic	16	3.7	ND @ 0.26	5.6	3.2	28.4	0.56 B	7.5
Barium	111	54.8	27.4	65.9	161	12.4 B	22.3 B	300
Cadmium	1.1	0.87	0.091 B	0.19 B	0.31 B	0.11 B	0.082 B	1
Chromium	27	21.3	7	9.4	49.9	5	5.9	10
Total Cyanide	2.3	0.66	0.58	3.9	0.75	1.1	ND @ 0.5	NSCG
Lead	273	96.1	2	46.3	9.5	1.3	1.8	NSCG
Mercury	1.7	0.16	ND @ 0.021	0.42	ND @ 0.022	ND @ 0.021	ND @ 0.02	0.1
Selenium	1.4	ND @ 0.2	ND @ 0.22	1.7	ND @ 0.24	ND @ 0.22	ND @ 0.21	2
Silver	0.19 B	0.33 B	ND @ 0.062	ND @ 0.049	ND @ 0.066	ND @ 0.062	ND @ 0.059	NSCG

NOTES:
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NA - Indicates Sample Was Not Analyzed For That Parameter.
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J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 3 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
RCRA METALS AND TOTAL CYANIDE IN SOIL
MARCH 2004

Sample Number:	GPE7 (1.5-2)	GPE7 (2.5-3)	GPE7 (8-9)	GPE7 (48-49)	GPE8 (1.5-2)	GPE8 (22-23)	GPE8 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403173-003	0403394-007	0403394-008	0403506-002	0402776-004	0403300-003	0403300-004	
Depth(ft):	1.5 - 2	2.5 - 3	8 - 9	48 - 49	1.5 - 2	22 - 23	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/2/2004	3/9/2004	3/10/2004	3/11/2004	2/26/2004	3/4/2004	3/4/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Arsenic	17.3	7.9	15.9	11.3	13.5	0.99 B	0.92 B	7.5
Barium	110	232	93.2	40.9	118	220	16.9 B	300
Cadmium	0.4 B	0.26 B	0.65	0.12 B	0.64	0.27 B	0.089 B	1
Chromium	10.4	5.1	32.8	19.9	9.8	241	5.6	10
Total Cyanide	ND @ 0.62	68.6	1.7	ND @ 0.58	3.5	ND @ 0.59	ND @ 0.58	NSCG
Lead	161	421	114	6.4	94	60.4	1.6	NSCG
Mercury	2.2	2.7	0.3	ND @ 0.019	0.78	ND @ 0.02	ND @ 0.019	0.1
Selenium	2.7	0.99	0.51 B	ND @ 0.21	2	ND @ 0.21	ND @ 0.21	2
Silver	0.57 B	0.63 B	0.23 B	0.11 B	0.63 B	0.073 B	0.065 B	NSCG

NOTES:
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NA - Indicates Sample Was Not Analyzed For That Parameter.
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B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 3 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
RCRA METALS AND TOTAL CYANIDE IN SOIL
MARCH 2004

Sample Number:	GPE9 (1.5-2)	GPE9 (12-13)	GPE9 (48-49)	GPE10 (1.5-2)	GPE10 (7-8)	GPE10 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-002	0403681-002	0403681-003	0403085-003	0403681-004	0403681-005	
Depth(ft):	1.5 - 2	12 - 13	48 - 49	1.5 - 2	7 - 8	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/1/2004	3/16/2004	3/16/2004	2/27/2004	3/15/2004	3/16/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Arsenic	59.8	0.37 B	0.48 B	12.5	5.3	1.8	7.5
Barium	49.2	19.3 B	39.4	78.6	112	18.2 B	300
Cadmium	ND @ 0.029	ND @ 0.025	0.044 B	0.081 B	ND @ 0.026	0.078 B	1
Chromium	25.1	6.7	12	10.2	72.5	10	10
Total Cyanide	71.3	1.1	ND @ 0.61	43.7	ND @ 0.65	ND @ 0.58	NSCG
Lead	121	1.5	1.6	180	8.9	0.37	NSCG
Mercury	10 B	ND @ 0.021	ND @ 0.02	6.5	ND @ 0.022	ND @ 0.019	0.1
Selenium	7.4	ND @ 0.22	ND @ 0.22	2.7	ND @ 0.24	ND @ 0.21	2
Silver	ND @ 0.057	0.088 B	ND @ 0.061	0.51 B	0.13 B	0.13 B	NSCG

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NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 3 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
RCRA METALS AND TOTAL CYANIDE IN SOIL
MARCH 2004

Sample Number:	GPE11 (1.5-2)	GPE11 (9-9.5)	GPE11 (17-18)	GPE11 (48-49)	GPE12 (1.5-2)	GPE12 (19-20)	GPE12 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0402776-005	0403169-005	0403169-006	0403169-007	0403085-004	0403506-003	0403506-004	
Depth(ft):	1.5 - 2	9 - 9.5	17 - 18	48 - 49	1.5 - 2	19 - 20	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/26/2004	3/3/2004	3/3/2004	3/3/2004	2/27/2004	3/11/2004	3/12/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Arsenic	34.5	10.7	202	26.7	14.3	1.3	10.7	7.5
Barium	191	69.2	175	172	101	52	17.1 B	300
Cadmium	ND @ 0.028	ND @ 0.026	ND @ 0.025	ND @ 0.024	0.59	0.084 B	0.19 B	1
Chromium	15.3	33.6	40	7.8	18.8	19.2	6	10
Total Cyanide	58.9	ND @ 0.65	ND @ 0.63	ND @ 0.59	2.2	ND @ 0.57	ND @ 0.59	NSCG
Lead	174	15.9	12.3	11.2	199	2.3	1.1	NSCG
Mercury	10.1 B	0.85	ND @ 0.021	ND @ 0.024	1.1	ND @ 0.019	ND @ 0.02	0.1
Selenium	3.2	0.68	0.95	0.84	1.8	ND @ 0.2	ND @ 0.21	2
Silver	0.14 B	ND @ 0.052	ND @ 0.05	ND @ 0.048	3	0.075 B	0.11 B	NSCG

NOTES:
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NA - Indicates Sample Was Not Analyzed For That Parameter.
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J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.

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TABLE 3 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
RCRA METALS AND TOTAL CYANIDE IN SOIL
MARCH 2004

Sample Number:	GPE13 (1.5-2)	GPE13 (13-14)	GPE13 (22-23)	GPE13 (48-49)	GPE20 (1.5-2)	GPE22 (48-49)	GPE25 (7-8)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-005	0403681-006	0403681-007	0403681-008	0402776-006	0403169-008	0403506-005	
Depth(ft):	1.5 - 2	13 - 14	22 - 23	48 - 49	1.5 - 2	48 - 49	7 - 8	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/1/2004	3/17/2004	3/17/2004	3/17/2004	2/26/2004	3/3/2004	3/12/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Arsenic	2.6	4.2	3.2	0.81 B	14.5	17.5	229	7.5
Barium	51.4	45.3	53.6	20.4 B	114	85.4	38.6	300
Cadmium	ND @ 0.021	ND @ 0.03	0.17 B	0.14 B	0.6	ND @ 0.022	0.098 B	1
Chromium	12.1	19.9	24.3	6	9.4	10.5	18.1	10
Total Cyanide	ND @ 0.53	ND @ 0.74	ND @ 0.59	ND @ 0.56	3.2	ND @ 0.56	1.7	NSCG
Lead	129	12	34.8	1.2	80.5	2.1	36.8	NSCG
Mercury	0.26	0.029 B	ND @ 0.02	ND @ 0.019	0.65	ND @ 0.019	0.06	0.1
Selenium	0.86	ND @ 0.27	ND @ 0.21	0.24 B	2.1	0.57	1.3	2
Silver	ND @ 0.042	0.3 B	0.14 B	0.13 B	0.54 B	ND @ 0.045	0.099 B	NSCG

NOTES:
ND - Indicates Compound Was Not Detected At The Method Detection Limit.
NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NSCG - Indicates No Soil Cleanup Guidance established.
Soil samples GPE20, GPE22 and GPE25 are field duplicate samples.

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TABLE 3 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
RCRA METALS AND TOTAL CYANIDE IN SOIL
MARCH 2004

Sample Number:	FB02262004	FB03032004	FB03122004
Lab Sample ID No:	0402776-007	0403173-004	0403506-006
Depth(ft):	0	0	0
Sample Type:	WATER	WATER	WATER
Sample Date:	2/26/2004	3/2/2004	3/12/2004
Units:	ug/L	ug/L	ug/L
Arsenic	ND @ 0.0022	ND @ 2.1	ND @ 2.1
Barium	ND @ 0.0003	ND @ 1.9	ND @ 1.9
Cadmium	ND @ 0.0002	0.43 B	0.34 B
Chromium	ND @ 0.005	ND @ 0.6	0.69 B
Total Cyanide	ND @ 0.01	ND @ 50	ND @ 10
Lead	ND @ 0.0016	ND @ 0.7	1.1 B
Mercury	ND @ 0.0001	ND @ 0.1	ND @ 0.1
Selenium	ND @ 0.0023	ND @ 1.8	ND @ 1.8
Silver	ND @ 0.0004	0.5 B	0.59 B

NOTES:

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NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At A Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported In Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.

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TABLE 4
GREENPOINT FORMER MGP SITE INVESTIGATION
PCBS IN SOIL
MARCH 2004

Sample Number:	GPE1 (1.5-2)	GPE1 (7-8)	GPE1 (48-49)	GPE2 (1.5-2)	GPE2 (8-9)	GPE2 (47-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-001B	0403506-001B	0403681-001B	0402776-001B	0403173-001B	0403173-002B	
Depth(ft):	1.5 - 2	7 - 8	48 - 49	1.5 - 2	8 - 9	47 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/27/2004	3/12/2004	3/15/2004	2/26/2004	3/2/2004	3/3/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Aroclor 1016	ND @ 0.039	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.04	ND @ 0.039	
Aroclor 1221	ND @ 0.078	ND @ 0.079	ND @ 0.076	ND @ 0.075	ND @ 0.082	ND @ 0.08	
Aroclor 1232	ND @ 0.039	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.04	ND @ 0.039	
Aroclor 1242	ND @ 0.039	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.04	ND @ 0.039	1/10
Aroclor 1248	ND @ 0.039	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.04	ND @ 0.039	
Aroclor 1254	ND @ 0.039	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.04	ND @ 0.039	
Aroclor 1260	ND @ 0.039	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.04	ND @ 0.039	

NOTES:

ND - Indicates Compound Was Not Detected At The Method Detection Limit.
NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At a Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported in Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NYSDEC SCG of 1/10 indicates 1 for surface soils and 10 for subsurface soils

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TABLE 4 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
PCBS IN SOIL
MARCH 2004

Sample Number:	GPE3 (1.5-2)	GPE3 (4-5)	GPE3 (48-49)	GPE4 (2-2.5)	GPE4 (9-10)	GPE4 (18-19)	GPE4 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0402776-002B	0402776-003B	0403169-001B	0403169-002B	0403300-001B	0403300-002B	0403394-002B	
Depth(ft):	1.5 - 2	4 - 5	48 - 49	2 - 2.5	9 - 10	18 - 19	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/26/2004	2/26/2004	3/2/2004	3/1/2004	3/5/2004	3/5/2004	3/8/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Aroclor 1016	ND @ 0.21	ND @ 0.037	ND @ 0.04	ND @ 0.038	ND @ 0.04	ND @ 0.39	ND @ 0.04	
Aroclor 1221	ND @ 0.42	ND @ 0.075	ND @ 0.081	ND @ 0.077	ND @ 0.081	ND @ 0.075	ND @ 0.082	
Aroclor 1232	ND @ 0.21	ND @ 0.037	ND @ 0.04	ND @ 0.038	ND @ 0.04	ND @ 0.39	ND @ 0.04	
Aroclor 1242	ND @ 0.21	ND @ 0.037	ND @ 0.04	ND @ 0.038	ND @ 0.04	ND @ 0.39	ND @ 0.04	1/10
Aroclor 1248	ND @ 0.21	ND @ 0.037	ND @ 0.04	ND @ 0.038	ND @ 0.04	ND @ 0.39	ND @ 0.04	
Aroclor 1254	ND @ 0.21	ND @ 0.037	ND @ 0.04	ND @ 0.038	ND @ 0.04	ND @ 0.39	ND @ 0.04	
Aroclor 1260	ND @ 0.21	ND @ 0.037	ND @ 0.04	ND @ 0.038	ND @ 0.04	ND @ 0.39	ND @ 0.04	

NOTES:

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NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At a Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported in Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NYSDEC SCG of 1/10 indicates 1 for surface soils and 10 for subsurface soils

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TABLE 4 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
PCBS IN SOIL
MARCH 2004

Sample Number:	GPE5 (1.5-2)	GPE5 (9-10)	GPE5 (48-49)	GPE6 (1.5-2)	GPE6 (11-12)	GPE6 (16-17)	GPE6 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403169-003B	0403394-002B	0403394-003B	0403169-004B	0403394-004B	0403394-005B	0403394-006B	
Depth(ft):	1.5 - 2	9 - 10	48 - 49	1.5 - 2	11 - 12	16 - 17	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/2/2004	3/8/2004	3/9/2004	3/2/2004	3/9/2004	3/9/2004	3/9/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Aroclor 1016	ND @ 0.037	ND @ 0.037	ND @ 0.041	ND @ 0.041	ND @ 0.044	ND @ 0.041	ND @ 0.039	
Aroclor 1221	ND @ 0.075	ND @ 0.075	ND @ 0.082	ND @ 0.083	ND @ 0.088	ND @ 0.083	ND @ 0.079	
Aroclor 1232	ND @ 0.037	ND @ 0.037	ND @ 0.041	ND @ 0.041	ND @ 0.044	ND @ 0.041	ND @ 0.039	
Aroclor 1242	ND @ 0.037	ND @ 0.037	ND @ 0.041	ND @ 0.041	ND @ 0.044	ND @ 0.041	ND @ 0.039	1/10
Aroclor 1248	ND @ 0.037	ND @ 0.037	ND @ 0.041	ND @ 0.041	ND @ 0.044	ND @ 0.041	ND @ 0.039	
Aroclor 1254	ND @ 0.037	ND @ 0.037	ND @ 0.041	ND @ 0.041	ND @ 0.044	ND @ 0.041	ND @ 0.039	
Aroclor 1260	ND @ 0.037	ND @ 0.037	ND @ 0.041	ND @ 0.041	ND @ 0.044	ND @ 0.041	ND @ 0.039	

NOTES:

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NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At a Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported in Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NYSDEC SCG of 1/10 indicates 1 for surface soils and 10 for subsurface soils

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TABLE 4 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
PCBS IN SOIL
MARCH 2004

Sample Number:	GPE7 (1.5-2)	GPE7 (2.5-3)	GPE7 (8-9)	GPE7 (48-49)	GPE8 (1.5-2)	GPE8 (22-23)	GPE8 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403173-003B	0403394-007B	0403394-008B	0403506-002B	0402776-004B	0403300-003B	0403300-004B	
Depth(ft):	1.5 - 2	2.5 - 3	8 - 9	48 - 49	1.5 - 2	22 - 23	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/2/2004	3/9/2004	3/10/2004	3/11/2004	2/26/2004	3/4/2004	3/4/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Aroclor 1016	ND @ 0.041	ND @ 0.046	ND @ 0.04	ND @ 0.038	ND @ 0.039	ND @ 0.039	ND @ 0.038	
Aroclor 1221	ND @ 0.083	ND @ 0.093	ND @ 0.081	ND @ 0.077	ND @ 0.079	ND @ 0.079	ND @ 0.078	
Aroclor 1232	ND @ 0.041	ND @ 0.046	ND @ 0.04	ND @ 0.038	ND @ 0.039	ND @ 0.039	ND @ 0.038	
Aroclor 1242	ND @ 0.041	ND @ 0.046	ND @ 0.04	ND @ 0.038	ND @ 0.039	ND @ 0.039	ND @ 0.038	1/10
Aroclor 1248	ND @ 0.041	ND @ 0.046	ND @ 0.04	ND @ 0.038	ND @ 0.039	ND @ 0.039	ND @ 0.038	
Aroclor 1254	ND @ 0.041	ND @ 0.046	ND @ 0.04	ND @ 0.038	ND @ 0.039	ND @ 0.039	ND @ 0.038	
Aroclor 1260	ND @ 0.041	ND @ 0.046	ND @ 0.04	ND @ 0.038	ND @ 0.039	ND @ 0.039	ND @ 0.038	

NOTES:

ND - Indicates Compound Was Not Detected At The Method Detection Limit.
NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At a Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported in Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NYSDEC SCG of 1/10 indicates 1 for surface soils and 10 for subsurface soils

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TABLE 4 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
PCBS IN SOIL
MARCH 2004

Sample Number:	GPE9 (1.5-2)	GPE9 (12-13)	GPE9 (48-49)	GPE10 (1.5-2)	GPE10 (7-8)	GPE10 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-002B	0403681-002B	0403681-003B	0403085-003B	0403681-004B	0403681-005B	
Depth(ft):	1.5 - 2	12 - 13	48 - 49	1.5 - 2	7 - 8	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/1/2004	3/16/2004	3/16/2004	2/27/2004	3/15/2004	3/16/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Aroclor 1016	ND @ 2.4	ND @ 0.041	ND @ 0.04	ND @ 0.8	ND @ 0.043	ND @ 0.038	
Aroclor 1221	ND @ 4.8	ND @ 0.083	ND @ 0.081	ND @ 1.6	ND @ 0.088	ND @ 0.078	
Aroclor 1232	ND @ 2.4	ND @ 0.041	ND @ 0.04	ND @ 0.8	ND @ 0.043	ND @ 0.038	
Aroclor 1242	ND @ 2.4	ND @ 0.041	ND @ 0.04	ND @ 0.8	ND @ 0.043	ND @ 0.038	1/10
Aroclor 1248	ND @ 2.4	ND @ 0.041	ND @ 0.04	ND @ 0.8	ND @ 0.043	ND @ 0.038	
Aroclor 1254	ND @ 2.4	ND @ 0.041	ND @ 0.04	ND @ 0.8	ND @ 0.043	ND @ 0.038	
Aroclor 1260	ND @ 2.4	ND @ 0.041	ND @ 0.04	ND @ 0.8	ND @ 0.043	ND @ 0.038	

NOTES:
ND - Indicates Compound Was Not Detected At The Method Detection Limit.
NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At a Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported in Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NYSDEC SCG of 1/10 indicates 1 for surface soils and 10 for subsurface soils

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TABLE 4 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
PCBS IN SOIL
MARCH 2004

Sample Number:	GPE11 (1.5-2)	GPE11 (9-9.5)	GPE11 (17-18)	GPE11 (48-49)	GPE12 (1.5-2)	GPE12 (19-20)	GPE12 (48-49)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0402776-005B	0403169-005B	0403169-006B	0403169-007B	0403085-004B	0403506-003B	0403506-004B	
Depth(ft):	1.5 - 2	9 - 9.5	17 - 18	48 - 49	1.5 - 2	19 - 20	48 - 49	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	2/26/2004	3/3/2004	3/3/2004	3/3/2004	2/27/2004	3/11/2004	3/12/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Aroclor 1016	ND @ 0.93	ND @ 0.043	ND @ 0.041	ND @ 0.039	ND @ 0.039	ND @ 0.038	ND @ 0.039	
Aroclor 1221	ND @ 1.9	ND @ 0.087	ND @ 0.084	ND @ 0.08	ND @ 0.079	ND @ 0.076	ND @ 0.079	
Aroclor 1232	ND @ 0.93	ND @ 0.043	ND @ 0.041	ND @ 0.039	ND @ 0.039	ND @ 0.038	ND @ 0.039	
Aroclor 1242	ND @ 0.93	ND @ 0.043	ND @ 0.041	ND @ 0.039	ND @ 0.039	ND @ 0.038	ND @ 0.039	1/10
Aroclor 1248	ND @ 0.93	ND @ 0.043	ND @ 0.041	ND @ 0.039	ND @ 0.039	ND @ 0.038	ND @ 0.039	
Aroclor 1254	ND @ 0.93	ND @ 0.043	ND @ 0.041	ND @ 0.039	ND @ 0.039	ND @ 0.038	ND @ 0.039	
Aroclor 1260	ND @ 0.93	ND @ 0.043	ND @ 0.041	ND @ 0.039	ND @ 0.039	ND @ 0.038	ND @ 0.039	

NOTES:

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J - Indicates That Compound Was Detected At a Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported in Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
NYSDEC SCG of 1/10 indicates 1 for surface soils and 10 for subsurface soils

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TABLE 4 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
PCBS IN SOIL
MARCH 2004

Sample Number:	GPE13 (1.5-2)	GPE13 (13-14)	GPE13 (22-23)	GPE13 (48-49)	GPE20 (1.5-2)	GPE22 (48-49)	GPE25 (7-8)	NYSDEC SCGs (MG/KG)
Lab Sample ID No:	0403085-005B	0403681-006B	0403681-007B	0403681-008B	0402776-006B	0403169-008B	0403506-005B	
Depth(ft):	1.5 - 2	13 - 14	22 - 23	48 - 49	1.5 - 2	48 - 49	7 - 8	
Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	
Sample Date:	3/1/2004	3/17/2004	3/17/2004	3/17/2004	2/26/2004	3/3/2004	3/12/2004	
Units:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Aroclor 1016	ND @ 0.035	ND @ 0.049	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.037	ND @ 0.042	
Aroclor 1221	ND @ 0.071	ND @ 0.99	ND @ 0.079	ND @ 0.075	ND @ 0.076	ND @ 0.075	ND @ 0.085	
Aroclor 1232	ND @ 0.035	ND @ 0.049	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.037	ND @ 0.042	
Aroclor 1242	ND @ 0.035	ND @ 0.049	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.037	ND @ 0.042	1/10
Aroclor 1248	ND @ 0.035	ND @ 0.049	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.037	ND @ 0.042	
Aroclor 1254	ND @ 0.035	ND @ 0.049	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.037	ND @ 0.042	
Aroclor 1260	ND @ 0.035	ND @ 0.049	ND @ 0.039	ND @ 0.037	ND @ 0.037	ND @ 0.037	ND @ 0.042	

NOTES:

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NA - Indicates Sample Was Not Analyzed For That Parameter.
D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At a Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported in Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.
NYSDEC SCGs Taken From The Most Current Edition Of TAGM #4046.
Soil samples GPE20, GPE22 and GPE25 are field duplicate samples.
NYSDEC SCG of 1/10 indicates 1 for surface soils and 10 for subsurface soils

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TABLE 4 (cont.)
GREENPOINT FORMER MGP SITE INVESTIGATION
PCBS IN SOIL
MARCH 2004

Sample Number:	FB02262004	FB03032004	FB03122004
Lab Sample ID No:	0402776-007B	0403173-004B	0403506-006B
Depth(ft):	0	0	0
Sample Type:	WATER	WATER	WATER
Sample Date:	2/26/2004	3/3/2004	3/12/2004
Units:	ug/L	ug/L	ug/L
Aroclor 1016	ND @ 1	ND @ 1	ND @ 1
Aroclor 1221	ND @ 2	ND @ 2	ND @ 2
Aroclor 1232	ND @ 1	ND @ 1	ND @ 1
Aroclor 1242	ND @ 1	ND @ 1	ND @ 1
Aroclor 1248	ND @ 1	ND @ 1	ND @ 1
Aroclor 1254	ND @ 1	ND @ 1	ND @ 1
Aroclor 1260	ND @ 1	ND @ 1	ND @ 1

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D - Indicates Sample Was Diluted.
J - Indicates That Compound Was Detected At a Concentration Below The Method Detection Limit.
B - Indicates Compound Was Also Reported in Quality Assurance/Quality Control Blanks.
N - Indicates Presumptive Evidence Of A Compound For Tentatively Identified Compounds.
X - Indicates A Suspected Column Bleed.

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GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

Quality Assurance Project Plan

Greenpoint Energy Center

Brooklyn, New York
Site No.: 224052

Submitted to:
National Grid
287 Maspeth Avenue
Brooklyn, NY 11201

Submitted by:
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One Greenwood Avenue
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January 2009
Project 081200

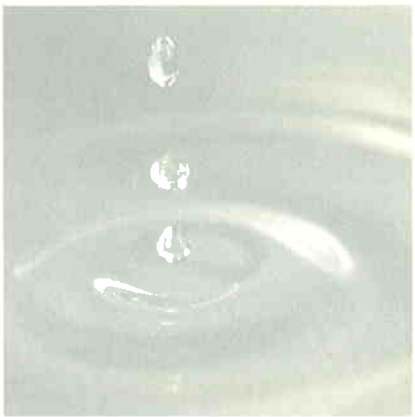


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Appendix

A Laboratory Quality Manual

Abbreviations and Acronyms

ASP	Analytical Service Protocols
ASTM	American Society for Testing and Materials
CAS	Chemical Abstract Service
CHMM	Certified Hazardous Materials Manager
CMS	Chip Measurement System
CLP	Contract Laboratory Protocol
COC	Chain Of Custody
DQO	Data Quality Objective
DO	Dissolved Oxygen
DUSR	Data Usability Summary Report
ELAP	Environmental Laboratory Approval Program
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectroscopy
GEI	GEI Consultants, Inc.
IRM	Interim Remedial Measure
IWP	Investigation Work Plan
LCS	Labortory Control Sample
LEL	Lower Explosive Limit
LEP	Licenced Environmental Professional (Connecticut)
MDL	Method Detection Limit
MGP	Manufactured Gas Plant
MPH	Master of Public Health
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PID	Photoionization Detector
PM	Project Manager
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
%R	Percent Recovery
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation Recovery Act
RI	Remedial Investigation
RL	Reporting Limit
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SD	Standard Deviation
SOP	Standard Operating Procedures
SVOC	Semivolatile Organic Compound

Abbreviations and Acronyms (cont.)

TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Identified Compounds
TOX	Total Organic Halides
TPH	Total Petroleum Hydrocarbons
USDOT	United States Department of Transporation
VOC	Volatile Organic Compound

MEASUREMENTS

mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mg/m^3	Milligrams per cubic meter

Quality Assurance Glossary

"Analytical Services Protocol" or "ASP" means the New York State Department of Environmental Conservation (NYSDEC's) compendium of approved EPA and NYSDEC laboratory methods for sample preparation and analysis and data handling procedures.

"Confirmatory Sample" means a sample taken after remedial action is expected to be complete to verify that the cleanup requirements have been met. This term has the same meaning as "post remediation sample."

"Contract laboratory program" or "CLP" means a program of chemical analytical services developed by the United States Environmental Protection Agency (EPA) to support CERCLA.

"Data Usability Summary Report, (DUSR)" is a document that provides a thorough evaluation of the analytical data to determine whether or not the data, as presented, meets the site/project specific criteria for data quality and use.

"Effective solubility" means the theoretical aqueous solubility of an organic constituent in groundwater that is in chemical equilibrium with a separate phase mixed product (product containing several organic chemicals). The effective solubility of a particular organic chemical can be estimated by multiplying its mole fraction in the product mixture by its pure phase solubility.

"Environmental Laboratory Accreditation Program" or "ELAP" means a program conducted by the New York State Department of Health (NYSDOH), which certifies environmental laboratories through on-site inspections and evaluation of principles of credentials and proficiency testing.

"Intermediate Sample" means a sample taken during the investigation process that will be followed by another sampling event to confirm that remediation was successful or to confirm that the extent of contamination has been defined to below a level of concern.

"Method detection limit" or "MDL" means the minimum concentration of a substance that can be measured and reported with a 99 percent confidence that the analyte concentration is greater than zero and is determined from the analysis of a sample in a given matrix containing the analyte.

"Non-targeted compound" means a compound detected in a sample using a specific analytical method that is not a targeted compound, a surrogate compound, a system monitoring compound or an internal standard compound.

"Practical quantitation limit" or "PQL" means the lowest quantification level of a given analyte that can be reliably achieved among laboratories within the specified limits of precision and accuracy of a given analytical method during routine laboratory operating conditions.

"PAH" means polycyclic aromatic hydrocarbon as defined by United States Environmental Protection Agency (USEPA) Method 8270.

"Quality assurance" or "QA" means the total integrated program for assuring the reliability of monitoring and measurement data, which includes a system for integrating the quality planning, quality assessment and quality improvement efforts to meet data end-use requirements.

"Quality assurance project plan" or "QAPP" means a document, which presents in specific terms the policies, organization, objectives, functional activities, and specific quality assurance/quality control activities designed to achieve the data quality goals or objectives of a specific project or operation.

"Quality control" or "QC" means the routine application of procedures for attaining prescribed standards of performance in the monitoring and measurement process.

"Semivolatile organic compound" or "SVOC" means compounds amenable to analysis by extraction of the sample with an organic solvent. For the purposes of this section, semivolatiles are those target compound list compounds identified in the statement of work in the current version of the EPA Contract Laboratory Program.

"Target analyte list" or "TAL" means the list of inorganic compounds/elements designated for analysis as contained in the version of the EPA Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, and Multi-Concentration in effect as of the date on which the laboratory is performing the analysis. For the purpose of this chapter, a Target Analyte List scan means the analysis of a sample for Target Analyte List compounds/elements.

"Targeted compound," means a hazardous substance, hazardous waste, or pollutant for which a specific analytical method is designed to detect that potential contaminant both qualitatively and quantitatively.

"Target compound list plus 30" or "TCL+30" means the list of organic compounds designated for analysis (TCL) as contained in the version of the EPA "Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration" in effect as of the date on which the laboratory is performing the analysis, and up to 30 non-targeted organic compounds (plus 30) as detected by gas chromatography/mass spectroscopy (GC/MS) analysis. For the purposes of this chapter, a Target Compound List+30 scan means the analysis of a sample for Target Compound List compounds and up to 10 non-targeted volatile organic compounds and up to 20 non-targeted semivolatile organic compounds using GC/MS analytical methods. Non-targeted compound criteria should be pursuant to the version of the EPA "Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, and Multi-Concentration" in effect as of the date on which the laboratory is performing the analysis.

"Tentatively identified compound" or "TIC" means a non-targeted compound detected in a sample using a GC/MS analytical method, which has been tentatively, identified using a mass spectral library search. An estimated concentration of the TIC is also determined.

"Unknown compound" means a non-targeted compound, which cannot be tentatively identified. Based on the analytical method used, the estimated concentration of the unknown compound may or may not be determined.

"Volatile organics" means organic compounds amenable to analysis by the purge and trap technique. For the purposes of this chapter, analysis of volatile organics means the analysis of a sample for either those priority pollutants listed as amenable for analysis using EPA method 624 or those target compounds identified as volatiles in the version of the EPA "Contract Laboratory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration" in effect as of the date on which the laboratory is performing the analysis.

"**Waste oil"** means used and/or reprocessed engine lubricating oil and/or any other used oil, including but not limited to: fuel oil, engine oil, gear oil, cutting oil, transmission fluid, oil storage tank residue, animal oil and vegetable oil, which has not subsequently been refined.

1. Purpose

GEI Consultants, Inc. (GEI) has prepared this Quality Assurance Project Plan (QAPP) to address the remedial investigations and remedial designs at the Greenpoint Energy Center Site located at 287 Maspeth Avenue in the Greenpoint neighborhood of Brooklyn, New York. The QAPP is a companion document to the approved *Pre-Design Investigation Work Plan* (Work Plan) and the approved *Field Sampling Plan* (FSP) for the Greenpoint Energy Center. This QAPP is broad in nature and is intended for use with future investigations. The project location is shown on Figure 1 of the Work Plans. The QAPP presents the project scope and goals, organization, objectives, sample handling procedures and specific Quality Assurance/Quality Control (QA/QC) procedures associated with the investigations and remedial actions at the Greenpoint Energy Center.

Furthermore, this QAPP identifies project responsibilities, prescribes guidance and specifications to make certain that:

- Samples are identified and controlled through sample tracking systems and chain-of-custody (COC) protocols
- Field and laboratory analytical results are valid and usable by adherence to established protocols and procedures
- All aspects of the investigation, from field to laboratory are documented to provide data that are technically sound and legally defensible

The requirements of this QAPP apply to all contractor activities as appropriate for their respective tasks.

This QAPP was prepared based upon guidance provided by the New York State Department of Environmental Conservation (NYSDEC):

- *Draft DER-10, Technical Guidance for Site Investigation and Remediation.* New York State Department of Environmental Conservation. December 2002.

Tables 1, 2 and 3 contain summaries of tentative soil and sediment, groundwater and surface water, and soil vapor and ambient air analyses, respectively. Table 4 summarizes anticipated analytical methods and frequency of quality assurance samples. Tables 5, 6, and 7 summarize the soil and sediment, groundwater and surface water, and soil vapor and ambient air quantitative limits, respectively. Tables 8 and 9 summarize the NYSDEC soil cleanup objectives and groundwater standards, criteria, and guidance, respectively.

Sediment criteria will follow the *NYSDEC Division of Fish, Wildlife and Marine Resources Technical Guidance for Screening Contaminated Sediments* dated January 25, 1999.

Surface water criteria will follow the *NYSDEC Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations* dated June 1998.

Soil vapor and ambient air criteria will follow the *New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York* dated October 2006.

2. Project Goals and Objectives

National Grid will conduct a Pre-Design Investigation as a non-emergency Cutoff Wall Interim Remedial Measure (IRM) and Remedial Investigations at the Greenpoint Energy Center Site (Site) in the Greenpoint neighborhood of Brooklyn, New York. The investigations are to assess key parameters needed to design the proposed Cutoff Wall IRM, and for capital improvement programs whose findings will be included in a Remedial Investigation (RI) report that will delineate impacts associated with the Greenpoint Former Manufactured Gas Plant (MGP).

2.1 Interim Remedial Measure Investigation

The scope of the IRM investigation is presented in the *Pre-Design Investigation Work Plan (IWP)*. The IWP scope includes the following tasks:

- Implementation of field investigations to gather geotechnical, hydrogeologic and environmental data
- Groundwater modeling and storm water runoff analysis to define the effects of the proposed cutoff wall on the groundwater regime
- Summation of findings in an Investigation Findings Report
- The cutoff wall design defining alignment, depth and materials of construction
- A Remedial Action Work Plan (RAWP) summarizing findings and presenting the design for approval to the NYSDEC

The IRM scope of work described in this work plan is intended to collect sufficient data to evaluate the hydrologic nature of the site, assess the cutoff wall configuration and geotechnical parameters necessary for its design, and in conjunction with other investigations at the site delineate the nature and extent of impacts associated with the operation of the former MGP.

2.2 Remedial Investigation

The IRM investigations in conjunction with other site investigations will serve as a Remedial Investigation for the Greenpoint Former Manufactured Gas Plant Site at the current Greenpoint Energy Center.

3. Project Organization and Responsibility

GEI will serve as the Consultant and is responsible for the implementation of Remedial Investigations, Remedial Design and Remedial Action Work Plans scopes of works, including the supervision of contractors, field activities, and the evaluation and interpretation of data. The Consultant will direct the sampling activities and coordinate submittal of samples to testing laboratories. The project organization and key personnel for the Consultant are listed below:

Program Manager: David Terry P.G., Licensed Environmental Professional (LEP)
Project Manager: Michael Zukauskas, P.E.
Field Manager: To be announced
Field Team Leader: To be announced
Quality Assurance Officer: Lorie MacKinnon
Corporate Health & Safety Officer: Robin DeHate, Master of Public Health (MPH), PhD(c), Certified Hazardous Materials Manager (CHMM)
Data Validators: Lorie MacKinnon, Lisa McDonough
Data Manager: Brian Skelly

The primary responsibilities of each of these personnel are described in the following table.

Key Project Personnel and Responsibilities		
Position	**Consultant Personnel**	**Areas of Responsibilities**
Program Manager	David Terry	▪ Overall program oversight ▪ Program management ▪ Schedule ▪ Client contact regarding program/project related issues ▪ Personnel and resource management ▪ Review of project submittals ▪ Financial management
Project Manager	Michael Zukauskas	▪ Client contact regarding project related issues ▪ Contracting and coordination of contractors ▪ Technical development and implementation of Work Plan and Field Sampling Plan ▪ Personnel and resource management ▪ Preparation and review of project submittals ▪ Preparation of project schedules ▪ Project budgeting
Field Manager	To be announced	▪ Client contact regarding field related issues ▪ Coordination of contractors ▪ Implementation of Work Plan and Field

Key Project Personnel and Responsibilities		
Position	**Consultant Personnel**	**Areas of Responsibilities**
		Sampling Plan ▪ Field personnel and resource management ▪ Preparation and review of project submittals ▪ Task budgeting
Field Team Leader	To be announced	▪ Client contact regarding project related issues on day to day basis as part of field operations ▪ Coordination of contractors ▪ Implementation of Work Plan and Field Sampling Plan ▪ Personnel and resource management ▪ Preparation of project submittals
Quality Assurance Officer	Lorie MacKinnon	▪ QA/QC for sampling and laboratory performance
Data Validator	Lorie MacKinnon, Lisa McDonough	▪ Perform data validation activities ▪ Prepare data usability summary reports ▪ Evaluate data with regards to quality objectives
Data Managers	Brian Skelly	▪ Manage raw data from the laboratory

A NYSDOH Environmental Laboratory Approval Program (ELAP) approved laboratory will be utilized to perform standard analytical chemistry parameters for soil, sediment, and groundwater samples including but not limited to:

- Volatile Organic Compounds (VOCs) according to United States Environmental Protection Agency (EPA) Method 8260B
- Semivolatile Organic Compounds (SVOCs) according to EPA Method 8270C
- Target Analyte List (TAL) Metals according to EPA Method 6000/7000 series
- Free Cyanide by EPA Methods 9013A (soil) and 9013B (water) for extraction and Microdiffusion, American Society for Testing and Materials (ASTM) Method D4282-02 for analysis
- Disposal Parameters (total metals, Toxicity Characteristic Leaching Procedure (TCLP) by EPA 1311, Resource Conservation Recovery Act (RCRA) 8 metals by EPA 6000/7000 series, TCLP pesticides EPA 8081A, TCLP herbicides by 8151A, TCLP VOC by EPA 8260B, TCLP SVOC by EPA 8270C, paint filter test, ignitability by EPA 1030 (soils)/EPA 1010 (water), corrosivity by EPA 9040 (water)/ 9045 (soils) , reactivity [cyanide by EPA 7.3.3.2 and sulfide by EPA 7.3.4.2] by , total petroleum hydrocarbons (TPH) by EPA 8015B/ 418.1, total Polychlorinated Biphenyls (PCBs) by EPA 8082, flashpoint, total organic halides (TOX) EPA 450.1, and % solids) [Note: disposal parameters are subject to change based on disposal facility]

The NYSDOH ELAP's relevant certifications are summarized in the following tables:

Table 1 provides a summary of soil analyses, Table 2 provides sediment analyses and Table 3 provides a summary of groundwater analyses. Table 4 provides a summary of quality assurance samples, holding times and analysis for each media. Table 5 provides a summary of the laboratory quantification limits for soil and sediment analysis. Table 6 provides a summary of the laboratory quantification limits for groundwater analysis. Table 7 provides a summary of the soil cleanup objectives. Table 8 provides a summary of the sediment cleanup objectives. Table 9 provides a summary of the groundwater Standards, Criteria and Guidance.

Drilling, test pit excavation, and survey contractors will be identified once the work plan is approved.

4. Quality Assurance Objectives

This section establishes the QA objectives for measurements that are critical to the project. The QA objectives are developed for relevant data quality indicators. These indicators include the method detection limit, reporting limit, precision, accuracy, completeness, representativeness, and comparability. The data quality objectives (DQOs) are based on project requirements and ensure: (1) that the data generated during the project are of known quality and (2) that the quality is acceptable to achieve the project's technical objectives provided in the Work Plan. All analytical data will be provided by the laboratory using the New York State Analytical Service Protocols (ASP) Category B deliverable format.

Quantitation Limits are laboratory-specific and reflect those values achievable by the laboratory performing the analyses. However, in order to ensure that the analytical methodologies are capable of achieving the DQOs, measurement performance criteria have been set for the analytical measurements in terms of accuracy, precision, and completeness. The analytical methods to be used at this site will provide a level of data quality and can be used to evaluate potential impacts to soil and groundwater from the former MGP operation, compared to NYSDEC Part 375 soil cleanup objectives and New York State Ambient Groundwater Standards, Criteria and Guidance values, and for purposes of risk assessment.

The overall QA objective is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting which will provide results that are scientifically valid, and the levels of which are sufficient to meet DQOs. Specific procedures for sampling, chain of custody, laboratory instruments calibration, laboratory analysis, reporting of data, internal quality control, and corrective action are described in other sections of the QAPP.

The data quality indicators are presented in subsections 4.1 through 4.6. Procedures to assess the data quality indicators are given below in Section 13.

4.1 Required Quantification Limit

The required quantification limit is the quantitative analytical level for individual analytes needed to make decisions relative to the objectives of the project. Quantitative limits may be expressed as the Method Detection Limit (MDL) or some quantitative level defined in terms relative to the program. It should be noted that there is some ambiguity in the definitions and use of terms that define quantification limits. The MDL presented herein is a well-defined and accepted entity, although attainable only under ideal laboratory conditions.

Method Detection Limit: The MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. MDL is determined from analysis of a sample in a given matrix type containing the analyte.

Practical Quantitation Limit (PQL): The PQL [also referred to as the reporting limit (RL)] is the concentration in the sample that corresponds to the lowest concentration standard of the calibration curve.

Laboratory MDLs and PQLs for soils, sediment, and groundwater are located on Tables 5 through 7, respectively.

4.2 Accuracy

Accuracy is the closeness of agreement between an observed value and an accepted reference value. The difference between the observed value and the reference value includes components of both systematic error (bias) and random error.

Accuracy in the field is assessed through the adherence to all field instrument calibration procedures, sample handling, preservation, and holding time requirements, and through the collection of equipment blanks prior to the collection of samples for each type of equipment being used (e.g., sample liners, drilling shoe, or stainless–steel sampling implements).

The laboratory will assess the overall accuracy of their instruments and analytical methods (independent of sample or matrix effects) through the measurement of "standards," materials of accepted reference value. Accuracy will vary from analysis to analysis because of individual sample and matrix effects. In an individual analysis, accuracy will be measured in terms of blank results, the percent recovery (%R) of surrogate compounds in organic analyses, or %R of spiked compounds in matrix spikes (MSs), matrix spike duplicates (MSDs) and/or laboratory control samples (LCSs). This gives an indication of expected recovery for analytes tending to behave chemically like the spiked or surrogate compounds. The laboratory accuracy will be evaluated in accordance with laboratory quality assurance plan and standard operating procedures located in Appendix A.

4.3 Precision

Precision is the agreement among a set of replicate measurements without consideration of the "true" or accurate value: i.e., variability between measurements of the same material for the same analyte. In environmental sampling, precision is the result of field sampling and analytical factors. Precision in the laboratory is easier to measure and control than precision in the field. Replicate laboratory analyses of the same sample provide information on analytical precision; replicate field samples provide data on overall measurement precision.

The difference between the overall measurement precision and the analytical precision is attributed to sampling precision. Precision is measured in a variety of ways including statistically, such as calculating variance or standard deviation. The difference between the overall measurement precision and the analytical precision is attributed to sampling precision.

Precision in the field is assessed through the collection and measurement of field duplicates. Field duplicates will be collected at a frequency of one per twenty investigative samples per matrix per analytical parameter, with the exception of the waste characterization parameters. Precision will be measured through the calculation of relative percent differences (RPDs) as described below in subsection 13.2. The resulting information will be used to assess sampling and analytical variability. Field duplicate RPDs must be less than 50% for soil samples and less than 30% for aqueous samples. These criteria apply only if the sample and/or duplicate results are >5x the quantitation limit; if both results are <5x the quantitation limit, the criterion will be doubled. Duplicate samples are described in below in subsection 5.1.10. Table 4 summarizes the number of duplicates per media sampled.

Precision in the laboratory is assessed through the calculation of RPD for duplicate samples. For organic analyses, laboratory precision will be assessed through the analysis of MS/MSD samples and field duplicates. For the inorganic analyses, laboratory precision will be assessed through the analysis of matrix duplicate pairs and field duplicate pairs. MS/MSD samples or matrix duplicate pairs will be performed at a frequency of one per twenty primary samples per matrix. Duplicate samples are described in below in subsection 5.1.10. Table 4 summarizes the number of duplicates per media sampled.

4.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. “Normal conditions” are defined as the conditions expected if the sampling plan was implemented as planned. The objective for completeness is a sufficient amount of valid data to achieve a predetermined statistical level of confidence. Critical samples must be identified and plans must be formulated to secure requisite valid data for these samples.

Field completeness is a measure of the amount of (1) valid measurements obtained from all the measurements taken in the project and (2) valid samples collected. The field completeness objective is greater than 90 percent.

Laboratory completeness is a measure of the amount of valid measurements obtained from all valid samples submitted to the laboratory. The laboratory completeness objective is greater than 95 percent.

To ensure that these percentages are met, materials for crucial parameters will be retained if re-sampling is required and strict adherence to holding times will be required.

4.5 Representativeness

Representativeness is a qualitative parameter that expresses the degree to which data accurately and precisely represents either a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary. To ensure representativeness, the sampling locations have been selected to provide coverage over a wide area and to highlight potential trends in the data.

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Work Plan and FSP are followed and that proper sampling, sample handling, and sample preservation techniques are used.

Representativeness in the laboratory is ensured by using the proper analytical procedures, appropriate methods, and meeting sample-holding times. These are provided within Appendix A.

4.6 Comparability

Comparability is a qualitative parameter that expresses the confidence with which one data set can be compared to another. Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Work Plan and FSP are followed and that proper sampling techniques are used. Maximization of comparability with previous data sets is expected because the sampling design and field protocols are consistent with those previously used.
Comparability is dependent on the use of recognized EPA or equivalent analytical methods and the reporting of data in standardized units. To facilitate data comparison, the data-reporting format as presented below will be used:

- Conventions (units reported as): for solids (weight/unit weight [i.e., mg/kg]); for liquids (weight/unit volume [i.e., mg/L]); for air (weight/unit volume [i.e., mg/m^3]).
- Use common chemical name with corresponding chemical abstract system (CAS) code.
- Report all data for soils on a dry-weight basis.

5. Sampling Plan

Environmental sampling will include soil, sediment, groundwater, and waste characterization sampling. Sampling may include soil vapor, ambient air, and surface water sampling. Subsurface soil borings and monitoring wells will be installed utilizing drilling methods presented in the FSP. Test pits may be excavated using methods presented in the FSP. Sediment cores will be installed utilizing methods presented in the FSP. Groundwater samples will be collected utilizing low-flow sampling methods, peristaltic pumps, bailers, whale pumps, or bladder pumps. Performing grab or composite sampling by appropriate hand-held sampling equipment will be the preferred method for waste characterization sampling. Analytical samples and analysis methods are described in the Work Plans. Sampling methods and procedures are described in FSP.

5.1 Sample Type, Location, and Frequency

5.1.1 Subsurface Borings and Associated Sampling

Soil boring locations will be sampled utilizing drilling methods listed in the FSP. The actual number of subsurface soil samples and their location will be determined upon site hydrologic properties and subsurface obstructions. The number and location of samples will vary based upon access and subsurface obstructions. Soils will be evaluated through visual, olfactory, and field screening observations in accordance with the FSP. Soil samples will be collected and submitted for laboratory analysis in general accordance with the Work Plans and the FSP. Monitoring wells will be installed in accordance with the Work Plans and FSP. A summary of subsurface soil sample analyses is located on Table 1.

5.1.2 Test Pit Sampling

A number of test pits may be proposed to be excavated at the site utilizing a backhoe or other excavation equipment. Soils will be evaluated through visual, olfactory, and field screening observations in accordance with the FSP. Soil samples will be collected and submitted for laboratory analysis in general accordance with the Work Plan and the FSP. A summary of subsurface soil samples and analyses is located on Table 1.

5.1.3 Surface Soil Samples

Collection of surface soil samples are not planned at this time; however, samples maybe collected if MGP impacts are observed from 0 to 2 inches below vegetative cover. Soils will be evaluated through visual, olfactory, and field screening observations in accordance with the FSP. Soil samples will be collected and submitted for laboratory analysis in general

accordance with the Work Plan and the FSP. A summary of surface soil analyses is located on Table 1.

5.1.4 Sediment Borings and Associated Sampling

Sediment boring locations will be sampled utilizing methods listed in the FSP. Tentative locations are discussed in the Work Plans. The actual number of sediment samples and their location may be modified based upon impact distribution. Sediment will be evaluated through visual, olfactory, and field screening observations in accordance with the FSP. Sediment samples will be collected and submitted for laboratory analysis in general accordance with the Work Plan and the FSP. A summary of sediment analyses is located on Table 1.

5.1.5 Monitoring Well Installation and Associated Sampling

Monitoring wells will installed be gauged and sampled. Monitoring wells will be installed in general accordance with the FSP. Groundwater samples will be collected and submitted for laboratory analysis in general accordance with the FSP and Work Plan. Water quality parameters including temperature, pH, turbidity, salinity, dissolved oxygen (DO), and specific conductance, will be collected prior to laboratory analysis in general accordance with the Work Plan and the FSP. A summary of groundwater samples analyses is located on Table 2.

5.1.6 Surface water samples

Although surface water samples are not planned at this time, these samples maybe collected in future investigations. Surface water locations will be sampled using direct method, peristaltic pump, Kemmerer bottle, and Van Doren sampler. Surface water samples will be collected near the surface and near the bottom of the canal at proposed sample locations. Surface water samples will be collected and submitted for laboratory analysis in general accordance with the FSP and Work Plan. Surface water discharges from the outfall locations along the Newtown Creek. The actual number of the outfall sample locations is will be determined during the outfall reconnaissance phase of the Work Plan. Water quality parameters including pH, specific conductance, temperature, turbidity, clarity, dissolved oxygen, and oxidation reduction potential will be collected prior to laboratory analysis in general accordance with the Work Plan and the FSP. A summary of surface water analyses is located on Table 2.

5.1.7 Soil Vapor Samples

Soil vapor sampling is not planned at this time; however, soil vapor points may be installed and samples will be collected in general accordance with the *New York State Department of Health's "Guidance for Evaluating Soil Vapor Intrusion in the State of New York"* and

National Grid's *"Draft Standard Operating Procedure- Soil Vapor Intrusion for MGP Sites in New York.* Within buildings, sub-slab soil vapor points will be installed to evaluate the soil vapor conditions. For exterior soil vapor locations, the soil vapor samples will be collected from temporary soil vapor probes, which will be installed, to a depth of approximately 5 feet below grade. Soil vapor samples will be collected in certified clean SUMMA® canisters and submitted for laboratory analysis in general accordance with the FSP and Work Plan. A summary of groundwater samples analyses are located on Table 3.

5.1.8 Ambient Air Samples

Indoor air and outdoor ambient air samples are not planned at this time, but maybe added in a future scope of work. Ambient air samples will be used to assess the potential for soil vapor intrusion into the buildings.

The proposed ambient air samples will be collected from the approximate breathing height (approximately 3 to 5 feet aboveground). The indoor air and outdoor air samples will be collected utilizing an individually certified 6-Liter SUMMA® canister with a laboratory-supplied flow controller that is calibrated to an 8-hour period. The regulator flow rate will not exceed 0.2 liters per minute. Each SUMMA® canister will be shipped to an approved-NYSDOH ELAP registered laboratory for analysis. The samples will be analyzed for VOCs and naphthalene by the modified EPA Method TO-15. QA/QC samples will include one blind duplicate ambient air sample (indoor or outdoor air sample) will be collected during each sampling event. The ambient air sampling will target the winter heating season between November 15 and March 30 in accordance with NYSDOH Soil Vapor Guidance.

Property information will also be collected in general accordance with the NYSDOH Center of Environmental Health's Indoor Air Quality Questionnaire and Building Form that is provided as Appendix B of the NYSDOH soil vapor guidance and National Grid's Draft Standard Operating Procedures for Soil Vapor Intrusion for MGP Sites in New York which is located in the FSP.

5.1.9 Investigation-Derived Waste Sample Collection

Waste classification sampling will be conducted for soils and liquid wastes. The purpose of characterizing a waste is for its proper off-site disposal. Composite samples will be collected from the on-site waste storage vessels (drums or roll-off) for parameters required by the approved disposal facility. Soil samples will be collected utilizing stainless steel sampling tools, shovel, or auger that had been decontaminated. Liquid samples will be collected utilizing disposable bailer, peristaltic pump, a pump with tubing, or other similar methods. These samples will be handled in general accordance with sample handling procedures presented in the FSP. Investigation derived waste samples will be analyzed for parameters listed in Section 3 or other analyses that are required by the National Grid-approved facility.

5.1.10 Field QC Sample Collection

Field QC samples are used to monitor the reproducibility and representativeness of field sampling activities. The field QC samples are handled transported and analyzed in the same manner as the associated field samples. Field QC samples will include equipment blanks, trip blanks, field duplicates and MS/MSDs. The relative quantity, field QC sample type and analysis is detailed on Table 4.

Equipment Blank Samples are used to monitor the adequacy of decontamination procedures and possible sources of contamination such as potential laboratory methodologies. Equipment blanks will consist of laboratory-supplied, distilled or de-ionized water and will be used to check for potential contamination of the equipment, which may cause sample contamination. Equipment blanks will be collected by routing the distilled water through decontaminated piece of sampling equipment or disposable sampling equipment into laboratory supplied bottles. Non-dedicated field equipment will be decontaminated as specified below in subsection 5.3. Equipment blanks will be submitted to the laboratory at a frequency of one per 20 samples per matrix per type of equipment being used per parameter. Equipment blanks will not be completed for waste characterization sampling activities.

Trip Blank Samples will consist of analyte free water and will be prepared by the laboratory. (Trip blanks are used to assess the potential for VOC contamination of samples due to contaminant migration during sample shipment and storage. Trip blanks will be transported to the project location unopened, stored with the site characterization samples, and kept closed until analyzed by the laboratory. Trip blanks will be submitted to the laboratory at a frequency of one per cooler, which contains samples submitted for VOC analysis.

Field Duplicate Samples, also referred as blind duplicate samples, are two samples that are submitted form the same interval using the same sample procedures. Field duplicates will be used to assess the sampling and analytical reproducibility. Both samples are collected utilizing the same methods and are submitted for the same laboratory analysis, however, different sample identification numbers are used. Field duplicates will be submitted at a frequency of one per 20 samples for all matrices and all parameters. Field duplicates will not be completed for waste characterization sampling activities.

MS/MSD Samples are two additional aliquots of the same sample submitted for the same parameters as the original sample. However, the additional aliquots are spiked with the compounds of concern. Matrix spikes provide information about the effect of the sample matrix on the measurement methodology. MS/MSDs will be submitted at a frequency of one per 20 investigative samples per matrix for organic and inorganic parameters. MS/MSDs will not be completed for waste characterization sampling activities.

Refer to Table 4 for a summary of QC sample preservation and container requirements.

5.2 Sample Preservation and Containerization

The analytical laboratory will supply the sample containers for the chemical samples. These containers will be cleaned by the manufacturer to meet or exceed all analyte specifications established in the latest United States EPA's Specifications and Guidance for Contaminant-Free Sample Containers. Certificates of analysis are provided with each bottle lot and maintained on file to document conformance to United States EPA specifications. The containers will be pre-preserved, where appropriate (Table 4).

5.3 Equipment Decontamination

All non-dedicated sampling equipment shall be cleaned between each use in the following manner:

- Wash/scrub with a biodegradable degreaser ("Simple Green") if there is oily residue on equipment surface
- Tap water rinse
- Wash and scrub with Alconox (or non-phosphate soap) and water mixture
- Tap water rinse
- All equipment used to collect samples for VOCs and SVOC analysis will then receive a methanol rinse followed by a de-ionized water rinse.
- All equipment used to collect samples for metals analysis will then receive a 10% nitric acid solution rinse followed by a de-ionized water rinse.
- Equipment will be wrapped in polyethylene plastic or aluminum foil for storage or transportation from the designated decontamination area to the sampling location, where appropriate.

The drilling and excavation equipment will be decontaminated in general accordance with methods described in the FSP.

Downhole groundwater sampling pumps will be cleaned by washing and scrubbing with an Alconox/water solution, rinsing with tap water and irrigating with de-ionized water. Decontamination fluids will be containerized into United States Department of Transportation (USDOT)/UN-approved 55-gallon drums or containment vessels and will be characterized and disposed of by National Grid at an approved disposal facility.

6. Documentation and COC

6.1 Sample Collection Documentation

6.1.1 Field Notes

Field notes documenting field activities will be maintained in a field notebook in general accordance with subsection 2.2 of the FSP. Field logbooks will provide the means of recording the chronology of data collection activities performed during the investigation. The logbook will be a bound notebook with water-resistant pages. Logbook entries will be dated, legible, and contain accurate and inclusive documentation of the activity. Each page of the logbook will be signed in permanent ink and dated. No erasures or obliterations of field notes will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark, which is signed and dated by the sampler. The correction shall be written adjacent to the error.

Field logbooks will be reviewed at regular intervals by the field team leader, site manager and project manager for completeness and representativeness. Logbooks will be supported by daily activity reports as described in subsection 2.3 of the FSP.

6.1.2 COC Records

Sample custody is discussed in detail below in subsection 6.2. COC records are initiated by the samplers in the field. The field portion of the custody documentation should include:

- The project name
- Signature(s) of sampler (s) responsible for sample custody
- Sample ID number
- Date and time of collection
- Whether the sample is grab or composite
- Names of individuals involved in sampling
- Air bill or other shipping number (if applicable)

On a regular basis (daily or on such a basis that all holding times will be met), samples will be transferred to the custody of the respective laboratories, via third-party commercial carriers or via laboratory courier service. Sample packaging and shipping procedures, and

field COC procedures are described below in subsection 6.2.1 of this Plan. Sample receipt and log-in procedures at the laboratory are described below in subsection 6.2.2 of this Plan.

6.1.3 Sample Labeling

Each sample will be labeled with a pre-printed adhesive label using indelible ink. The label should include the date and time of collection, sampler's initials, tests to be performed, preservative (if applicable), and a unique identification. The following identification scheme will be used:

PRIMARY SAMPLES TYPES	QA/QC SAMPLE TYPES
SOIL SAMPLES	**FIELD BLANKS**
Surface Soil-Number (SAMPLE DEPTH-FEET)	SAMPLE-[DATE]
GPE-SS-01 (0-0.2)	GPE-SS-FB-033108
Test Pit-Number (SAMPLE DEPTH-FEET)	GPE-SB-FB-033108
GPE-TP-01 (5-6)	GPE-SED-FB-033108
Direct Push Boring-Number (SAMPLE DEPTH-FEET)	GPE-MW-FB-033108
	MATRIX SPIKE/DUP
DP-01 (10-15)	SAMPLE [Number] [DEPTH] [EITHER Matrix Spike (MS) OR Matrix Spike Duplicate (MSD)]
Hand Auger-Number (SAMPLE DEPTH-FEET)	GPE-SS-01 (0-2) MS
GPE-HA-01 (10-15)	GPE-SS-01 (0-2) MSD
Geotechnical Boring-Number (SAMPLE DEPTH-FEET)	GPE-SB-01 (10-15) MS
SB-01 (10-15)	GPE-SB-01 (10-15) MSD
SEDIMENT SAMPLES	GPE-SED-01 (15-20) MS
Sediment Boring Number (SAMPLE DEPTH-FEET)	GPE-SED-01 (15-20) MSD
GPE-SED-01 (0-5)	GPE-MW-01 MS
GROUNDWATER SAMPLES	GPE-MW-01 MSD
Direct Push Monitoring Well- Number	**TRIP BLANKS**
GPE-MW-01	SAMPLE-[DATE]
Test Well/Sump-Number	GPE-TB-063008
GPE-TW-03	**BLIND DUPLICATES**
SEDIMENT SAMPLES	SAMPLE - Number [XX][DATE]
Sediment Core-Number	GPE-SS-XX-030309
GPE-SED-01	GPE-SB-XX-030309
	GPE-SED-XX-030309
	GPE-TW-XX-030309

This sample label contains the authoritative information for the sample. Inconsistencies with other documents will be settled in favor of the vial or container label unless otherwise corrected in writing from the field personnel collecting samples or the Data Manager and/or the GEI Project QA Officer.

6.1.4 Sample Handling

Samples will be handled in general accordance with Section 13.0 of the FSP.

6.2 Sample Custody

The COC provides a record of the custody of any environmental field sample from the time of collection to the delivery to the laboratory. Custody is one of several factors that are necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files.

A sample is considered to be under a person's custody if:

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

6.2.1 Field Custody Procedures

Samples will be collected following the sampling procedures indicated in the Work Plan and the FSP. A summary of samples and collection methods are provided above in Section 5 of this QAPP. Documentation of sample collection is described above in subsection 6.1. Sample COC and packaging procedures are summarized below. These procedures will ensure that the samples will arrive at the laboratory with the COC intact.

- The field sampler is personally responsible for the care and custody of the samples until they are transferred or dispatched properly. Field procedures have been designed such that as few people as possible will handle the samples.
- All bottles will be identified by the use of sample labels with sample numbers, sampling locations, date/time of collection, and type of analysis. The sample numbering system is presented above in subsection 6.1.3.
- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions.
- Samples will be accompanied by a completed COC form. The sample numbers and locations will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents the transfer of custody of samples from the sampler to another person, to a mobile laboratory, and to the laboratory facility.

- All shipments will be accompanied by the COC record identifying the contents. The original record will accompany the shipment, and copies will be retained by the sampler and placed in the project files.
- Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the cooler and covered with clear plastic tape after being signed by field personnel.
- If the samples are sent by common carrier, the air bill will be used. Air bills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody forms since the custody forms will be sealed inside the sample cooler and the custody seals will remain intact.
- Samples remain in the custody of the sampler until transfer of custody is completed. This consists of delivery of samples to the laboratory sample custodian, and signature of the laboratory sample custodian on COC document as receiving the samples and signature of sampler as relinquishing samples.

6.2.2 Laboratory Custody Procedures

After accepting custody of the shipping containers, the laboratory will document the receipt of the shipping containers by signing the COC record. The laboratory will:

- Examine the shipping containers to verify that the custody tape is intact
- Examine all sample containers for damage
- Determine if the temperature required for the requested testing program has been maintained during shipment and document the temperature on the COC records
- Compare samples received against those listed on the COC
- Verify that sample holding times have not been exceeded
- Examine all shipping records for accuracy and completeness
- Determine sample pH (if applicable) and record on COC forms
- Sign and date the COC immediately (if shipment is accepted) and attach the air bill
- Note any problems associated with the coolers and/or samples on the cooler receipt form and notify the laboratory project manager, who will be responsible for contacting the GEI data manager

- Attach laboratory sample container labels with unique laboratory identification and test
- Place the samples in the proper laboratory storage.

Following receipt, samples will be logged in according to the following procedure:

- The samples will be entered into the laboratory tracking system. At a minimum, the following information will be entered: project name or identification, unique sample numbers (both client and internal laboratory), type of sample, required tests, date and time of laboratory receipt of samples, and field ID provided by field personnel.
- The completed COC, air bills, and any additional documentation will be placed in the final evidence file.

7. Calibration Procedure

7.1 Field Instruments

Field instruments will be calibrated according to the manufacturer's specifications. Air monitoring instruments will be calibrated to a known reference gas standard and ambient air outside the work zone. Calibration will be completed daily. If concentrations of VOCs are encountered above the reference gas standard, the soil screening photoionization detector (PIDs) may be calibrated or re-checked against the reference gas standard. Water quality meters will be calibrated with known reference solutions. All calibration procedures performed will be documented in the field logbook and will include the date/time of calibration, name of person performing the calibration, reference standard used, and the readings. The following equipment has been identified for use to implement the Work Plan.

Subsurface Soil Sampling Activities:

- RAE Systems MultiRAE Plus equipped with VOC (10.6 eV lamp), lower explosive limit (LEL), percent oxygen
- RAE Systems MiniRAE 2000 (PID) with 10.6 eV lamp
- Drager Chip Measurement System (CMS) and compound specific chips (including benzene, etc.)
- MIE pDR 1200 with cyclone and pump [particulate monitor]
- MSA LC Pump or SKC 224-PCXR4 [air pump for dust monitoring]
- BIOS Dry Cal DC Lite Primary Flow Meter Model ML [air pump calibration]

Groundwater Sampling Activities

- In-Situ Multi-Parameter Troll 9000
- YSI 6280 XLM water quality meter

Similar field equipment can be substituted that perform the same functions can be substituted if selected equipment is not available from equipment supplier.

7.2 Laboratory Instruments

Calibration procedures for a specific laboratory instrument will consist of initial calibrations, initial calibration verifications, and/or continuing calibration verification. Detailed descriptions of the calibration procedures for a specific laboratory instrument are included in the laboratory's quality assurance plan, which describe the calibration procedures, their frequency, acceptance criteria, and the conditions that will require recalibration.

8. Sample Preparation and Analytical Procedures

Analytical samples will be collected in general accordance with the FSP and as specified in the Work Plan. Tables 1 through 3 provide a sample collection matrix that is separated by media. Analytical samples will be collected into laboratory-preserved sample containers and will be preserved as indicated in Table 4.

9. Data Reduction, Validation, and Reporting

Appropriate QC measures will be used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data is a primary goal in this project. Complete data packages suitable for data validation to support the generation of a Data Usability Summary Report (DUSR) according to NYSDEC requirements will be provided by the analytical laboratory.

9.1 Field Data Evaluation

Measurements and sample collection information will be transcribed directly into the field logbook or onto standardized forms. If errors are made, results will be legibly crossed out, initialed and dated by the person recording the data, and corrected in a space adjacent to the original (erroneous) entry. Reviews of the field records by the field team leader, site manager, and project manager will ensure that:

- Logbooks and standardized forms have been filled out completely and that the information recorded accurately reflects the activities that were performed.
- Records are legible and in accordance with good record keeping procedures, i.e., entries are signed and dated, data are not obliterated, changes are initialed, dated, and explained.
- Sample collection, handling, preservation, and storage procedures were conducted in accordance with the protocols described in the FSP and Work Plan, and that any deviations were documented and approved by the appropriate personnel.

9.2 Analytical Data Validation

GEI will be responsible for performing an independent validation of the analytical data. Project-specific procedures will be used to validate analytical laboratory data. The basis for the validation will be the USEPA CLP National Functional Guidelines for Organic Data Review (February 2005) and the USEPA CLP National Functional Guidelines for Inorganic Data Review (October 2004), modified to accommodate the criteria in the analytical methods used in this program, and Region II Standard Operating Procedures (SOPs) for CLP Organic Data review (Revision 11, June 1996) and Evaluation of Metals for the CLP Program (Revision 11, February 1992). Critical functions for determining the validity of generated data are: (1) strict adherence to the analytical methods, (2) assurance that the instrumentation employed was operated in accordance with defined operating procedures, (3) assurance that

quality parameters built into the analytical procedures have been adhered to, and (4) confirmation that the DQOs have been met.

Table 4 highlights the QC criteria and holding time requirements for all analyses conducted under this program. These criteria will be used to evaluate and qualify the data during validation.

GEI or qualified contracted personnel will validate all analytical samples collected as part of the Pinelawn/Farmingdale Hortonsphere Site Characterization. Samples collected for waste classification will not be validated. Validation will include all technical holding times, as well as QC sample results (blanks, surrogate spikes, laboratory duplicates, MS/MSDs, and LCSs), tunes, internal standards, calibrations, target compound identification, and results calculations.

For all analyses, the laboratory will report results, which are below the laboratory's reporting limit; these results will be qualified as estimated (J) by the laboratory. The laboratory may be required to report Tentatively Identified Compounds (TICs) for the VOC and SVOC analyses; this will be requested by GEI on an as-needed basis

The overall completeness of the data package will also be evaluated by the data validator. Completeness checks will be administered on all data to determine whether full data deliverables were provided. The reviewer will determine whether all required items are present and request copies of missing deliverables.

Upon completion of the validation, a report will be prepared. This report will summarize the samples reviewed, elements reviewed, any nonconformance with the established criteria, and validation actions. Data qualifiers will be consistent with EPA National Functional Guidelines. This report will be in a format consistent with NYSDEC's DUSR.

9.3 Analytical Data Validation

Laboratory deliverables will consist of an original hard copy data package that is in general accordance with NYSDEC ASP Category B data deliverable requirements.

10. Internal Quality Control

Laboratory and field quality internal control checks will be used to ensure the data quality objectives. At a minimum, this will include:

- Matrix spike and/or matrix spike duplicate samples
- Matrix duplicate analyses
- Laboratory control spike samples
- Instrument calibrations
- Instrument tunes for VOC 8260B and SVOC 8270C analyses
- Method and/or instrument blanks
- Surrogate spikes for organic analyses
- Internal standard spikes for VOC 8260B and SVOC 8270C analyses
- Detection limit determination and confirmation by analysis of low-level calibration standard

The laboratory quality plan for the selected ELAP is located in Appendix A.

Field quality control samples will include:

- Equipment blanks as outlined in Table 4
- Field duplicate samples as outlined in Table 4
- Trip blanks as outlined in Table 4
- MS/MSDs as outlined in Table 4

11. Performance and System Audits

Audits are an independent means of: 1) evaluating the operation or capability of a measurement system, and 2) documenting the use of QC procedures designed to generate data of know and acceptable quality.

Field audits may be completed to assess sample collection protocols, determine the integrity of COC procedures, and evaluate sample documentation and data handling procedures. Field audits may be scheduled by the QA officer, Project Manager (PM), site manager or in-house consultant, at their discretion. Written records of audits and any recommendations for corrective action will be submitted to the PM.

The QA officer is the interface between management and project activities in matters of project quality. The QA officer will review the implementation of the QAPP. Reviews will be conducted at the completion of field activities and will include the results of any audits and an evaluation of the data quality.

12. Preventative Maintenance

Preventative maintenance will be performed on field equipment in accordance with the manufacturer's recommendations. Preventative maintenance to field will be provided by equipment vendor, U.S Environmental Rental Corporation, Pine Environmental Services, or other selected vendors. The following equipment has been identified for use to implement the Work Plan.

Subsurface Soil Sampling Activities:

- RAE Systems MultiRAE Plus equipped with VOC (10.6 eV lamp), LEL, percent oxygen
- RAE Systems MiniRAE 2000 PID with 10.6 eV lamp
- RAE Systems VRAE Surveying Monitor with LEL, hydrogen cyanide, hydrogen sulfide, carbon monoxide, and percent oxygen
- Drager CMS and compound specific chips
- MIE pDR 1200 with cyclone and pump
- MSA LC Pump
- BIOS DCL-5k pump calibrator

Groundwater Sampling Activities

- In-Situ Troll 9000
- YSI 600 XLM

Similar equipment will be substituted that perform the same functions can be substituted if selected equipment is not available from equipment supplier.

Laboratory equipment calibration and maintenance procedures are specified in the ELAP laboratory quality manual located in Appendix A.

13. Specific Procedures to Assess Data Quality Indicators

QC analyses conducted as a part of the testing program will provide a quantitative quality assessment of the data generated and their adherence to the data quality indicators. The data quality indicators ensure that the quality assurance objectives for the project are met.

13.1 Detection Limits

13.1.1 Method Detection Limit

The MDL is defined as follows for all measurements:

$$MDL = (t[n-1,1-a=0.99]) \times (s)$$

where: s = standard deviation of the replicate analysis,
t(n-1, 1-a=0.99) = student's t-value for a one-sided, 99 percent confidence level and a standard deviation estimate with n-1 degrees of freedom

The MDLs calculated by the laboratory are determined under ideal conditions. MDLs for environmental samples are dependent on the sample aliquot, the matrix, the concentration of analyte, and interference present in the matrix, the percent of moisture, dilution factor, etc. The MDL for each sample analysis will be adjusted accordingly.

13.1.2 *Reporting Limit*

The RL is the concentration of an analyte in the sample that corresponds to the lowest concentration standard of the calibration curve. As with the MDLs, the RLs are dependent on the sample aliquot, the final sample volume, the percent of moisture, dilution factor, etc.

The RL is determined as follows:

$$RL = \frac{Lowest\ conc.\ std\ (ng)}{Volume\ injected\ (uL)} \ x \ \frac{Sample\ aliquot\ (mL\ or\ g)}{Final\ volume\ (mL)} \ x\ DF\ x \ \frac{100}{(100 - \%M)}$$

where: DF = dilution factor, including all dilutions or lost samples not accounted for in a sample aliquot/final volume ratio
%M = percent moisture for solid samples.

13.2 Precision

Variability will be expressed in terms of the RPD when only two data points exist. The RPD is calculated as:

$$RPD = \frac{(Larger\ Value - Smaller\ Value)}{[(Larger\ Value + Smaller\ Value)/2]} \ x\ 100\%$$

For data sets greater than two points, the percent relative standard deviation (percent RSD) is used as the precision measurement. It is defined by the equation:

$$Percent\ RSD = \frac{Standard\ Deviation}{Mean} \ x\ 100\%$$

Standard deviation (SD) is calculated as follows:

$$SD = \sqrt{\sum_{i=1}^{n} \frac{(y_i - y)^2}{n - 1}}$$

where: SD = standard deviation
yi = measured value of the ith replicate
y = mean of replicate measurements
n = number of replicates

For measurements such as pH, where the absolute variation is more appropriate, precision is usually reported as the absolute range (D) of duplicate measurements:

D = | first measurement - second measurement |

or as the absolute standard deviation previously given. RPD, %RSD, and D are independent of the error of the analyses and reflect only the degree to which the measurements agree with each other, not the degree to which they agree with the true value for the parameter measured.

13.3 Accuracy

Accuracy is related to the bias in a measurement system. Accuracy describes the degree of agreement of a measurement with a true value. Accuracy will be expressed as percent recovery for each matrix spike analyte by using the following equation:

$$\% \ Recovery = \frac{Css - Cus}{Csa} \ X \ 100\%$$

where: Css = measured concentration in spiked sample
Cus = measured concentration in unspiked sample
Csa = known concentration added to the sample

Accuracy for a measurement such as pH is expressed as bias in the analysis of a standard reference sample according to the equation:

$$Bias = pH_m - pH_t$$

where: pH_m = measured pH
pH_t = the true pH of the standard reference sample

13.4 Completeness

Data completeness is a measure of the amount of usable data resulting from a measurement effort. For this program, completeness will be defined as the percentage of valid data obtained compared to the total number of measurements necessary to achieve our required statistical level of confidence for each test. The confidence level is based on the total number of samples proposed in the Work Plan.

Data completeness is calculated as:

$$Completeness = \frac{Number\ of\ valid\ data\ points}{Number\ of\ data\ points\ necessary\ for\ confidence\ level} x\ 100\%$$

The completeness goal is to generate a sufficient amount of valid data. GEI anticipates that 95 percent of the data will be complete. Data validation criteria discussed in the work plan and Section 10 of this QAPP will be used to determine data completeness. Any data deficiencies and their effect on project goals will be evaluated in the DUSR.

13.5 Representativeness

Representativeness is a qualitative statement that expresses the extent to which the sample accurately and precisely represents the characteristics of interest of the study. Representativeness is primarily concerned with the proper design of the sampling program and is best ensured by proper selection of sampling locations and the taking of a sufficient number of samples. It is addressed by describing the sampling techniques, the matrices sampled, and the rationale for the selection of sampling locations, which are discussed in the field sampling plan and Work Plan

13.6 Comparability

Comparability is a qualitative parameter expressing the confidence that one set of data can be compared to another. Comparability is possible only when standardized sampling and analytical procedures are used.

14. Corrective Action

If unacceptable conditions are identified as a result of audits or are observed during field sampling and analysis, the PM, Field Team Leader, and QA officer will document the condition and initiate corrective procedures. The specific condition or problem will be identified, its cause will be determined, and appropriate action will be implemented.

The entire sampling program will be under the direction of the PM and QA officer. The emphasis in this program is on preventing problems by identifying potential errors, discrepancies, and gaps in the data collection, laboratory analysis, and interpretation process. Any problems identified will be promptly resolved. Likewise, follow-up corrective action is always an option in the event that preventative corrective actions are not effective.

The acceptance limits for the sampling and analyses to be conducted in this program will be those stated in the method or defined by other means in the Work Plan and FSP. Corrective actions are likely to be immediate in nature and most often will be implemented by the contracted laboratory analyst or the PM. The corrective action will usually involve recalculation, reanalysis, or repeating a sample run.

14.1 Immediate Corrective Action

Corrective action in the field may be needed when the sample requirements are changed (i.e., more/less samples, sampling locations other than those specified in the Work Plan), or when sampling procedures and/or field analytical procedures require modification, etc. due to unexpected conditions. The field team may identify the need for corrective action. The Field Team Leader, Site Manager, and PM will approve the corrective action and notify the QA officer. The PM and QA officer will approve the corrective measure. The Field Team Leader and Site Manager will ensure that the corrective measure is implemented by the field team.

Corrective actions will be implemented and documented in the field record book. Documentation will include:

- A description of the circumstances that initiated the corrective action
- The action taken in response
- The final resolution
- Any necessary approvals

No staff member will initiate corrective action without prior communication of findings through the proper channels.

Corrective action in the laboratory will be completed in accordance with the quality assurance procedures located in the Appendix A. Any corrective actions completed by the laboratory will be documented in both the laboratory's corrective action files, and the narrative data report sent from the laboratory to the PM. If the corrective action does not rectify the situation, the laboratory will contact the PM, who will determine the action to be taken and inform the appropriate personnel.

If potential problems are not solved as an immediate corrective action, the contractor will apply formalized long-term corrective action if necessary.

Tables

Table 1
Soil and Sediment Field Sampling Matrices
Greenpoint Energy Center Site
Brooklyn New York

Sample I.D.	SOIL & SEDIMENT BORING SAMPLE SELECTION PROTOCOL: 1. Shallow soil/sediment within observed impacts (0 to 5' bgs); 2. Subsurface soil/sediment within heaviest observed impacts below 5 feet (if present); 3. Subsurface soil/sediment below deepest observed visual impacts. IF NO IMPACTS ARE OBSERVED IN BORING: 1. Shallow soil/sediment (0 to 5' bgs); 2. Water table interface (if applicable); 3. Completion depth of boring.								Analysis (Method[1])								
	Sample Number																
	Number Samples Proposed	Number Samples Collected	Date Collected	0 to 5' bgs	Heaviest Impacted Zone below 5 feet (if Present)	Water Table Interface	Subsurface soil/sediment below deepest observed visual impacts	Completion depth of boring	VOCs (8260B)	SVOCs (8270C)	TAL Metals (6000/7000)	Total Cyanide (9012)[2]	Herbicides (8151A)	PCBs (8082)	Pesticides (8081A)	Total Organic Carbon (9060)	Hexavalent Chromium (3060A/7196)
Subsurface Soil																	
GPE-TP-XX	TBD				---		---	---	X	X	X	X	X	X	X	X[4]	X
GPE-SB-XX	TBD								X	X	X	X	X[3]	X[3]	X[3]	X[4]	X[3]
GPE-MW-XX	TBD								X	X	X	X	X[3]	X[3]	X[3]	X[4]	X[3]
Surface Soils																	
GPE-SS-01	TBD			---	---	---	---	---	X	X	X	X	X	X	X	X	X
Sediment																	
GPE-SED-01	TBD								X	X	X	X	X[4]	X[4]	X[4]	X[4]	X[4]

Notes:
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
TAL - target analyte list
PCBs - polychlorinated biphenols
TBD - to be determined
1. Chemical analysis test methods specified are from U.S. EPA SW-846 test methods.
2. If elevated cyanide readings are present in a sample, then analysis for cyanide speciation may be completed
3. One sample from within the fill in each soil boring
4. Samples will be collected at the Program Manager's discretion

Table 2
Groundwater and Surface Water Sampling Matrix
Greenpoint Energy Center
Brooklyn, New York

Sample I.D.	GROUNDWATER SAMPLE SELECTION PROTOCOL: Collect one groundwater sample at the water table or installed monitoring well depth.				Water Quality Measurements								Analysis (Method[1])									
	Sample Number			Sample Zone	pH	Specific Conductance	Temperature	Oxidation Reduction Potential (ORP)	Turbidity	Salinity	Dissolved Oxygen	Water Column Clarity	VOCs (EPA Method 8260B)	SVOCs (EPA 8270C)	TAL Metals (EPA Method 6000/7000)	Herbicides (EPA Method 8151A)	PCBs/ Pesticides (EPA 8082)	Total Cyanide (EPA Method 9012)	Hexavalent Chromium (EPA Method 7196)	Total Organic Carbon (EPA Method 9060)[1]	Nitrate/Nitrite (EPA Method 300.0)	Fecal Coliform
	Number Samples Proposed	Number Samples Collected	Date Collected	Water Table																		
Groundwater																						
GPE-MW-XX	TBD											-	X	X	X	X	X	X	X	X	-	-
Surface Water																						
GPE-SW-XX	TBD												X	X	X	X	X	X	X	X	X	X

Notes:
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
TBD - to be determined
TAL - target analyte list

[1]Sample will be analyzed at Program Manager's discretion

Table 3
Soil Vapor and Ambient Air Field Sampling Matrix
Greenpoint Energy Center
Brooklyn, New York

Sample I.D.	**SAMPLE SELECTION PROTOCOL:** **1. Collect one soil vapor sample at the installed soil vapor point depth.** **2. Collect indoor air and outdoor air samples from the height of the breathing zone, approximately 3-5 feet above the ground surface.**			Analysis (Method)
	Sample Number			VOCs (expanded) (modified TO-15)
	Number Samples Proposed	Number Samples Collected	Date Collected	
Soil Vapor				
GPE-SV-XX	TBD			X
Indoor Air				
GPE-IA-XX	TBD			X
Outdoor Air				
GPE-OA-XX	TBD			X

Notes:
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
TBD - to be determined

Table 4
Analytical Methods/Quality Assurance Summary
Greenpoint Energy Center
Brooklyn, New York

Media	Number of Primary Samples	QA/QC Samples				Analytical Parameters	Method	Preservative	Holding Time	Container
		TB	FB[2]	DUP	MS/MSD					
Subsurface Soil	TBD	1 per ship	1 per 20	1 per 20	1 per 20	VOCs	8260B	Cool to 4°C	14 days to analysis	Wide mouth 2-oz. VOA, clear glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	SVOCs	8270C	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	TBD	---	1 per 20	1 per 20	1 per 20	TAL Metals	6000/7000	Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Total Cyanide	9012	Cool to 4° C	28 days to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	TBD	---	1 per 20	1 per 20	1 per 20	TOC	9060	Cool to 4°C	28 days to analysis	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	PCBs	8082	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
Surface Soil	TBD	1 per ship	1 per 20	1 per 20	1 per 20	VOCs	8260B	Cool to 4°C	14 days to analysis	Wide mouth 2-oz. VOA, clear glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	SVOCs	8270C	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	TBD	---	1 per 20	1 per 20	1 per 20	TAL Metals	6000/7000	Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Total Cyanide	9012	Cool to 4° C	14 days to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Herbicides	8151A	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	TBD	---	1 per 20	1 per 20	1 per 20	PCBs	8082	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Pesticides	8081A	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. and 4oz. clear glass jars[1]
Sediment	TBD	1 per ship	1 per 20	1 per 20	1 per 20	VOCs	8260B	Cool to 4°C	14 days to analysis	Wide mouth 2-oz. VOA, clear glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	SVOCs	8270C	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	PCBs	8082A	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Pesticides	8081A	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Herbicides	8151A	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis	Wide mouth 4-oz. clear glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	TAL Metals	6000/7000	Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Total Cyanide	9012	Cool to 4°C	28 days to analysis	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	TOC	9060	Cool to 4°C	28 days to analysis	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Nitrate/Nitrite	300.0	Cool to 4°C	48 hours after extraction	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Sulfate	300.0	Cool to 4° C	28 days to analysis	Wide mouth 8-oz. clear glass jar[1]
	TBD	---	1 per 20	1 per 20	1 per 20	Fecal Coliform	SM-9222D	Cool to 4° C/ $Na_2S_2O_3$ (FB only)	6 hours to analysis	4-oz. clear glass jar
	TBD	---	---	1 per 20	---	Bulk Density % Water Content Grain Size[3]	ASTM D2937 D2216 D422/ 4464	None	None	Wide mouth 8-oz. clear glass jar
Ground Water	TBD	1 per ship	1 per 20	1 per 20	1 per 20	VOCs	8260B	pH<2 with HCl, Cool to 4°C	14 days to analysis	(2) 40 mL VOA vials
	TBD	---	1 per 20	1 per 20	1 per 20	SVOCs	8270C	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	(2) 1 L amber glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	TAL Metals	6000/7000	pH<2 with HNO_3; Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	(1) 500 mL polyethylene container
	TBD	---	1 per 20	1 per 20	1 per 20	Total Cyanide	9012	NaOH to pH>12/Cool to 4°C	14 days to analysis	(1) 500 mL polyethylene container
	TBD	---	1 per 20	1 per 20	1 per 20	Herbicides	8151A	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	(1)-1 L amber glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	PCBs	8082	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	(1)-1 L amber glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	Pesticides	8081A	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	1)-1 L amber glass jar

Table 4
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Brooklyn, New York

Media	Number of Primary Samples	QA/QC Samples				Analytical Parameters	Method	Preservative	Holding Time	Container
		TB	FB[2]	DUP	MS/MSD					
Surface Water	TBD	1 per ship	1 per 20	1 per 20	1 per 20	VOCs	8260B	pH<2 with HCl, Cool to 4°C	14 days to analysis	(2) 40 mL VOA vials
	TBD	---	1 per 20	1 per 20	1 per 20	SVOCs	8270C	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	(2) 1 L amber glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	PCBs	8082A	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	(1) 1 L amber glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	Pesticides	8081A	Cool to 4°C;	7 days to extraction; 40 days from extraction to analysis	(1) 1 L amber glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	Herbicides	8151A	Cool to 4°C	7 days to extraction; 40 days from extraction to analysis	(1) 1 L amber glass jar
	TBD	---	1 per 20	1 per 20	1 per 20	TAL Metals	6000/7000	pH<2 with HNO_3; Cool to 4°C	28 days to analysis for mercury; 6 months to analysis for other metals	(1) 500 mL polyethylene container
	TBD	---	1 per 20	1 per 20	1 per 20	Total Cyanide	9012	NaOH to pH>12/Cool to 4°C	14 days to analysis	(1) 500 mL polyethylene container
	TBD	---	1 per 20	1 per 20	1 per 20	Nitrate/Nitrite	300.0	Cool to 4°C	48 hours to analysis	(1) 500 mL polyethylene container[4]
	TBD	---	1 per 20	1 per 20	1 per 20	Sulfate	300.0	Cool to 4°C	As soon as possible (within 3 days of collection)	(1) 500 mL polyethylene container[4]
	TBD	---	1 per 20	---	1 per 20	Fecal Coliform	SM-9222D	$Na_2S_2O_3$/Cool to 4°C	6 hours to analysis	(1)125 mL polyethylene container
Soil Vapor	TBD	---	---	1 per 20	---	VOCs (including naphthalene)	*TO-15 Modified	None	14 Days to analysis	2.7-Liter Summa Canister
Indoor Air	TBD	---	---	1 per 20	---	VOCs (including naphthalene)	*TO-15 Modified	None	14 Days to analysis	6-Liter Summa Canister
Outdoor Air	TBD	---	---	1 per 20	---	VOCs (including naphthalene)	*TO-15 Modified	None	14 Days to analysis	6-Liter Summa Canister

Notes:
[1]: SVOC, Total Cyanide, TAL metals, herbicides, pesticides and PCBs will be collected from the (1)- 8 oz jar and the (1)- 4 oz jar
[2]: Soil field blanks will include bottles listed in groundwater section of the table.
VOCs - volatile organic compounds
SVOCs - semivolatile organic compounds
TAL - target analyte list
PCBs - polychlorinated biphenols
* Expanded TO-15 list shown on Table 7
°C- Degrees Celsius
L - Liter
oz. - ounce
mL - Milliliter
HNO3 - Nitric acid
HCl - Hydrochloric Acid
NAOH-Sodium Hydroxide

Table 5
Quantification Limits for Soil and Sediment
Greenpoint Energy Center
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Surface/Subsurface Soil & Sediment			
Metals by EPA Method 6000/7000 series			
Aluminum	258	20	mg/Kg
Antimony	11.7	1.14	mg/Kg
Arsenic	8	1.22	mg/Kg
Barium	2	0.18	mg/Kg
Beryllium	2	0.5	mg/Kg
Cadmium	3	1	mg/Kg
Calcium	85	11.6	mg/Kg
Chromium	3	0.34	mg/Kg
Cobalt	2	0.42	mg/Kg
Copper	5	0.8	mg/Kg
Iron	145	10.2	mg/Kg
Lead	9	0.76	mg/Kg
Magnesium	35	9.2	mg/Kg
Manganese	2.5	0.64	mg/Kg
Mercury	0.05	0.02	mg/Kg
Nickel	6.25	0.44	mg/Kg
Potassium	200	40	mg/Kg
Selenium	16	1.6	mg/Kg
Silver	3	0.32	mg/Kg
Sodium	94	20	mg/Kg
Thallium	20	4.17	mg/Kg
Vanadium	4	0.36	mg/Kg
Zinc	20	3.8	mg/Kg
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270C			
1,2,4-Trichlorobenzene	333	55.96	ug/Kg
1,2-Dichlorobenzene	333	56.43	ug/Kg
1,2-Diphenylhydrazine	333	32.86	ug/Kg
1,3-Dichlorobenzene	333	50.49	ug/Kg
1,4-Dichlorobenzene	333	52.75	ug/Kg
2,2-oxybis (1-chloropropane)	333	47.18	ug/Kg
2,4,5-Trichlorophenol	1667	120.96	ug/Kg
2,4,6-Trichlorophenol	333	85.18	ug/Kg
2,4-Dichlorophenol	333	108.95	ug/Kg
2,4-Dimethylphenol	333	172.3	ug/Kg
2,4-Dinitrophenol	1667	114.87	ug/Kg
2,4-Dinitrotoluene	333	60.09	ug/Kg
2,6-Dinitrotoluene	333	60.57	ug/Kg
2-Chloronaphthalene	333	48.46	ug/Kg
2-Chlorophenol	333	86.27	ug/Kg
2-Methylnaphthalene	333	52.92	ug/Kg
2-Methylphenol	333	89.03	ug/Kg
2-Nitroaniline	1667	42.32	ug/Kg
2-Nitrophenol	333	115.71	ug/Kg
3,3-Dichlorobenzidine	667	88.96	ug/Kg
3-Nitroaniline	1667	68.54	ug/Kg
4,6-Dinitro-2-methylphenol	1667	239.28	ug/Kg
4-Bromophenyl phenyl ether	333	51.16	ug/Kg

Table 5
Quantification Limits for Soil and Sediment
Greenpoint Energy Center
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Surface/Subsurface Soil & Sediment			
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270C (Continued)			
4-Chloro-3-methylphenol	333	112.76	ug/Kg
4-Chloroaniline	333	107.34	ug/Kg
4-Chlorophenyl phenyl ether	333	45.74	ug/Kg
4-Methylphenol	333	179.39	ug/Kg
4-Nitroaniline	667	48.17	ug/Kg
4-Nitrophenol	1667	141.69	ug/Kg
Acenaphthene	333	55.32	ug/Kg
Acenaphthylene	333	40.59	ug/Kg
Aniline	333	73.83	ug/Kg
Anthracene	333	54.55	ug/Kg
Benzidine	3333	1134.9	ug/Kg
Benzo(a)anthracene	333	45.31	ug/Kg
Benzo(a)pyrene	333	41.16	ug/Kg
Benzo(b)fluoranthene	333	93.11	ug/Kg
Benzo(ghi)perylene	333	36.99	ug/Kg
Benzo(k)fluoranthene	333	37.12	ug/Kg
Benzoic acid	1667	90.33	ug/Kg
Benzyl alcohol	333	62.93	ug/Kg
Bis(2-chloroethoxy)methane	333	57.03	ug/Kg
Bis(2-chloroethyl)ether	333	44.86	ug/Kg
Bis(2-ethylhexyl)phthalate	333	44.37	ug/Kg
Butyl benzyl phthalate	333	43.04	ug/Kg
Carbazole	333	48.63	ug/Kg
Chrysene	333	41.6	ug/Kg
Dibenzo(a,h)anthracene	333	36.71	ug/Kg
Dibenzofuran	333	52.67	ug/Kg
Diethyl phthalate	333	48.88	ug/Kg
Dimethyl phthalate	333	51.27	ug/Kg
Di-n-butyl phthalate	333	43.98	ug/Kg
Di-n-octyl phthalate	333	34.97	ug/Kg
Fluoranthene	333	41.87	ug/Kg
Fluorene	333	43.39	ug/Kg
Hexachlorobenzene	333	48.52	ug/Kg
Hexachlorobutadiene	333	67.85	ug/Kg
Hexachlorocyclopentadiene	333	247.96	ug/Kg
Hexachloroethane	333	59.22	ug/Kg
Indeno(1,2,3-cd)pyrene	333	33.74	ug/Kg
Isophorone	333	60.02	ug/Kg
Naphthalene	333	56.66	ug/Kg
Nitrobenzene	333	40.4	ug/Kg
n-Nitrosodimethylamine	333	48.87	ug/Kg
n-Nitroso-di-n-propylamine	333	44.63	ug/Kg
n-Nitrosodiphenylamine	333	49.76	ug/Kg
Pentachlorophenol	1667	287.85	ug/Kg
Phenanthrene	333	38.58	ug/Kg
Phenol	333	96.98	ug/Kg
Pyrene	333	45.56	ug/Kg
Pyridine	667	39.9	ug/Kg
Volatile Organic Compounds (VOCs) by EPA Method 8260B			
1,1,1-Trichloroethane	5	0.84	ug/Kg
1,1,2,2-Tetrachloroethane	5	1.21	ug/Kg
1,1,2-Trichloroethane	5	1.04	ug/Kg
1,1-Dichloroethane	5	0.81	ug/Kg
1,1-Dichloroethene	5	1.09	ug/Kg
1,2,3-Trichloropropane	5	1.62	ug/Kg
1,2,4-Trichlorobenzene	5	0.61	ug/Kg

Table 5
Quantification Limits for Soil and Sediment
Greenpoint Energy Center
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	Reporting Detection Limit	Method Detection Limit	Units
Surface/Subsurface Soil & Sediment			
Volatile Organic Compounds (VOCs) by EPA Method 8260B (Continued)			
1,2-Dichloroethane	5	0.99	ug/Kg
1,2-Dichloropropane	5	1.06	ug/Kg
2-Butanone (MEK)	10	1.78	ug/Kg
2-Chloroethylvinylether	5	1.37	ug/Kg
2-Hexanone	10	2.53	ug/Kg
4-Methyl-2-pentanone (MIBK)	5	1.18	ug/Kg
Acetone	20	3.15	ug/Kg
Acrolein	20	3.1	ug/Kg
Acrylonitrile	5	1.19	ug/Kg
Benzene	5	0.86	ug/Kg
Bromodichloromethane	5	0.84	ug/Kg
Bromoform	5	0.99	ug/Kg
Bromomethane	5	0.82	ug/Kg
Carbon disulfide	5	0.61	ug/Kg
Carbon tetrachloride	5	0.78	ug/Kg
Chlorobenzene	5	0.79	ug/Kg
Chloroethane	5	1.89	ug/Kg
Chloroform	5	0.53	ug/Kg
Chloromethane	5	0.9	ug/Kg
cis-1,2-Dichloroethene	5	1.04	ug/Kg
cis-1,3-Dichloropropene	5	0.78	ug/Kg
Dibromochloromethane	5	0.41	ug/Kg
Dichlorodifluoromethane	5	1.25	ug/Kg
Ethylbenzene	5	0.79	ug/Kg
Isopropyl ether	5	0.44	ug/Kg
Methylene chloride	20	2.21	ug/Kg
Methyl-tert-butyl-ether (MTBE)	5	0.93	ug/Kg
Styrene	5	1.06	ug/Kg
tert-Butyl alcohol	20	4.69	ug/Kg
Tetrachloroethene	5	0.7	ug/Kg
Toluene	5	0.84	ug/Kg
trans-1,2-Dichloroethene	5	0.58	ug/Kg
trans-1,3-Dichloropropene	5	0.92	ug/Kg
Trichloroethene	5	0.68	ug/Kg
Trichlorofluoromethane	5	0.6	ug/Kg
Trichlorotrifluoroethane	5	0.63	ug/Kg
Vinyl acetate	10	2.7	ug/Kg
Vinyl chloride	5	0.87	ug/Kg
Xylenes (total)	5	1.96	ug/Kg
Herbicides by EPA Method 8151A			
2,4-D	80	20.64	ug/Kg
2,4,5-TP (Silvex)	20	5.042	ug/Kg
2,4,5-T	20	5.149	ug/Kg
Pesticides by EPA Method 8082A			
4,4'-DDD	3.3	0.381	ug/Kg
4,4'-DDE	3.3	0.434	ug/Kg
4,4'-DDT	3.3	0.309	ug/Kg
Aldrin	2	0.356	ug/Kg
alpha-BHC	1.7	0.275	ug/Kg
alpha-Chlordane	1.7	0.11	ug/Kg
beta-BHC	1.7	0.269	ug/Kg
delta-BHC	1.7	0.103	ug/Kg
Dieldrin	3.3	0.321	ug/Kg
Endosulfan I	1.7	0.147	ug/Kg
Endosulfan II	3.3	0.17	ug/Kg

Table 5
Quantification Limits for Soil and Sediment
Greenpoint Energy Center
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Surface/Subsurface Soil & Sediment			
Pesticides by EPA Method 8082A (Continued)			
Endosulfan sulfate	3.3	0.173	ug/Kg
Endrin	5	0.89	ug/Kg
Endrin aldehyde	3.3	0.323	ug/Kg
Endrin ketone	3.3	0.144	ug/Kg
gamma-BHC (Lindane)	1.7	0.152	ug/Kg
gamma-Chlordane	1.7	0.091	ug/Kg
Heptachlor	1.7	0.15	ug/Kg
Heptachlor epoxide	1.7	0.114	ug/Kg
Methoxychlor	17	2.11	ug/Kg
Toxaphene	67	4.833	ug/Kg
PCBs by EPA Method 8082A			
Aroclor 1016	17	2.808	ug/Kg
Aroclor 1221	33	1.533	ug/Kg
Aroclor 1232	17	1.859	ug/Kg
Aroclor 1242	17	2.989	ug/Kg
Aroclor 1248	17	2.69	ug/Kg
Aroclor 1254	17	1.215	ug/Kg
Aroclor 1260	17	3.988	ug/Kg
Cyanide by EPA Method 9012A			
Cyanide	500	53	ug/Kg

Table 6
Quantification Limits for Groundwater and Surface Water
Greenpoint Energy Center
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Groundwater and Surface Water			
Cyanide by EPA Method 9012			
Cyanide, Total	10	1	ug/L
Herbicides by EPA Method 8151A			
2,4-D	4	0.435	ug/L
2,4,5-TP (Silvex)	1	0.0934	ug/L
2,4,5-T	1	0.0938	ug/L
Nitrate/Nitrite and Sulfate by EPA Method 300			
Nitrate as N (NO3-N)	0.1	0.008	mg/L
Nitrite as N (NO2-N)	0.1	0.002	mg/L
Sulfate	1	0.038	mg/L
Metals by EPA Method 6000/7000 series			
Aluminum	500	92	ug/L
Antimony	20	5.4	ug/L
Arsenic	40	3.9	ug/L
Barium	5	0.74	ug/L
Beryllium	5	0.54	ug/L
Cadmium	10	1.1	ug/L
Calcium	300	56	ug/L
Chromium	10	1.3	ug/L
Cobalt	10	1.8	ug/L
Copper	10	4.3	ug/L
Iron	100	54	ug/L
Lead	10	3	ug/L
Magnesium	100	26	ug/L
Manganese	15	6.9	ug/L
Mercury	0.4	0.07	ug/L
Nickel	10	1.9	ug/L
Potassium	400	191	ug/L
Selenium	30	5	ug/L
Silver	6	1.1	ug/L
Sodium	400	98	ug/L
Thallium	40	10	ug/L
Vanadium	6	1.5	ug/L
Zinc	50	11	ug/L
Total Organic Carbon by EPA Method 9060			
TOC	1	0.072	mg/L
Pesticides by EPA Method 8081A			
4,4'-DDD	0.15	0.014	ug/L
4,4'-DDE	0.1	0.009	ug/L
4,4'-DDT	0.1	0.01	ug/L
Aldrin	0.05	0.006	ug/L
alpha-BHC	0.05	0.011	ug/L
alpha-Chlordane	0.05	0.006	ug/L
beta-BHC	0.05	0.013	ug/L
delta-BHC	0.05	0.002	ug/L
Dieldrin	0.1	0.006	ug/L

Table 6
Quantification Limits for Groundwater and Surface Water
Greenpoint Energy Center
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Pesticides by EPA Method 8081A (Continued)			
Endosulfan I	0.05	0.004	ug/L
Endosulfan II	0.1	0.012	ug/L
Endosulfan sulfate	0.1	0.014	ug/L
Endrin	0.1	0.025	ug/L
Endrin aldehyde	0.1	0.0282	ug/L
Endrin ketone	0.1	0.0162	ug/L
gamma-BHC (Lindane)	0.05	0.005	ug/L
gamma-Chlordane	0.05	0.006	ug/L
Heptachlor	0.05	0.008	ug/L
Heptachlor epoxide	0.05	0.006	ug/L
Methoxychlor	0.5	0.041	ug/L
Toxaphene	2.5	0.215	ug/L
Polychlorinated Biphenyls (PCBs) by 8082A			
Aroclor 1016	0.5	0.113	ug/L
Aroclor 1221	1	0.207	ug/L
Aroclor 1232	0.5	0.055	ug/L
Aroclor 1242	0.5	0.04	ug/L
Aroclor 1248	0.5	0.052	ug/L
Aroclor 1254	0.5	0.052	ug/L
Aroclor 1260	0.5	0.055	ug/L
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270C			
1,2,4-Trichlorobenzene	10	0.68	ug/L
1,2-Dichlorobenzene	10	0.74	ug/L
1,2-Diphenylhydrazine	10	0.84	ug/L
1,3-Dichlorobenzene	10	0.68	ug/L
1,4-Dichlorobenzene	10	0.46	ug/L
2,2-oxybis (1-chloropropane)	10	0.62	ug/L
2,4,5-Trichlorophenol	50	0.78	ug/L
2,4,6-Trichlorophenol	10	0.79	ug/L
2,4-Dichlorophenol	10	0.84	ug/L
2,4-Dimethylphenol	10	0.73	ug/L
2,4-Dinitrophenol	50	5.13	ug/L
2,4-Dinitrotoluene	10	0.8	ug/L
2,6-Dinitrotoluene	10	0.59	ug/L
2-Chloronaphthalene	10	0.73	ug/L
2-Chlorophenol	10	0.6	ug/L
2-Methylnaphthalene	10	0.64	ug/L
2-Methylphenol	10	0.59	ug/L
2-Nitroaniline	50	1.12	ug/L
2-Nitrophenol	10	0.75	ug/L
3,3-Dichlorobenzidine	10	0.98	ug/L
3-Nitroaniline	50	0.67	ug/L
4,6-Dinitro-2-methylphenol	50	4.24	ug/L
4-Bromophenyl phenyl ether	10	0.91	ug/L
4-Chloro-3-methylphenol	10	0.51	ug/L
4-Chloroaniline	10	0.43	ug/L

Table 6
Quantification Limits for Groundwater and Surface Water
Greenpoint Energy Center
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270C (Continued)			
4-Chlorophenyl phenyl ether	10	0.82	ug/L
4-Methylphenol	10	0.33	ug/L
4-Nitroaniline	20	1.05	ug/L
4-Nitrophenol	50	1.85	ug/L
Acenaphthene	10	0.8	ug/L
Acenaphthylene	10	0.75	ug/L
Aniline	10	0.63	ug/L
Anthracene	10	0.99	ug/L
Benzidine	100	2.15	ug/L
Benzo(a)anthracene	10	1.19	ug/L
Benzo(a)pyrene	10	1.08	ug/L
Benzo(b)fluoranthene	10	1.54	ug/L
Benzo(ghi)perylene	10	1.04	ug/L
Benzo(k)fluoranthene	10	0.91	ug/L
Benzoic acid	50	5.88	ug/L
Benzyl alcohol	10	0.99	ug/L
Bis(2-chloroethoxy)methane	10	0.87	ug/L
Bis(2-chloroethyl)ether	10	0.87	ug/L
Bis(2-ethylhexyl)phthalate	10	1.31	ug/L
Butyl benzyl phthalate	10	0.96	ug/L
Carbazole	10	1.11	ug/L
Chrysene	10	0.97	ug/L
Dibenzo(a,h)anthracene	10	1.34	ug/L
Dibenzofuran	10	0.82	ug/L
Diethyl phthalate	10	0.82	ug/L
Dimethyl phthalate	10	0.63	ug/L
Di-n-butyl phthalate	10	1.14	ug/L
Di-n-octyl phthalate	10	1.3	ug/L
Fluoranthene	10	1.08	ug/L
Fluorene	10	0.77	ug/L
Hexachlorobenzene	10	1.07	ug/L
Hexachlorobutadiene	10	0.84	ug/L
Hexachlorocyclopentadiene	10	2.21	ug/L
Hexachloroethane	10	1.06	ug/L
Indeno(1,2,3-cd)pyrene	10	1.17	ug/L
Isophorone	10	0.66	ug/L
Naphthalene	10	0.66	ug/L
Nitrobenzene	10	0.79	ug/L
n-Nitroso-di-n-propylamine	10	0.7	ug/L
n-Nitrosodiphenylamine	10	1.08	ug/L
n-Nitrosomethylethylamine	10	0.5	ug/L
Pentachlorophenol	50	5.04	ug/L
Phenanthrene	10	0.66	ug/L
Phenol	10	0.35	ug/L
Pyrene	10	1.01	ug/L
Pyridine	20	2.31	ug/L

Table 6
Quantification Limits for Groundwater and Surface Water
Greenpoint Energy Center
Brooklyn, New York

	Reporting Detection Limit	Method Detection Limit	Units
Volatile Orangic Compounds (VOCs) by EPA Method 8260B			
1,1,1-Trichloroethane	5	0.4	ug/L
1,1,2,2-Tetrachloroethane	5	0.4	ug/L
1,1,2-Trichloroethane	5	0.6	ug/L
1,1-Dichloroethane	5	0.6	ug/L
1,1-Dichloroethene	5	0.7	ug/L
1,2,3-Trichloropropane	5	1.1	ug/L
1,2,4-Trichlorobenzene	5	0.9	ug/L
1,2-Dichloroethane	5	0.6	ug/L
1,2-Dichloropropane	5	0.9	ug/L
1,3-Dichloropropane	5	0.4	ug/L
2-Butanone (MEK)	5	1.2	ug/L
2-Chloroethylvinylether	5	0.6	ug/L
2-Hexanone	5	0.8	ug/L
4-Methyl-2-pentanone (MIBK)	5	0.7	ug/L
Acetone	5	1.4	ug/L
Acrolein	10	7.8	ug/L
Acrylonitrile	5	1.6	ug/L
Benzene	5	0.4	ug/L
Bromodichloromethane	5	0.4	ug/L
Bromoform	5	0.8	ug/L
Bromomethane	5	1.2	ug/L
Carbon disulfide	5	0.9	ug/L
Carbon tetrachloride	5	1	ug/L
Chlorobenzene	5	0.4	ug/L
Chloroethane	5	0.8	ug/L
Chloroform	5	0.7	ug/L
Chloromethane	5	0.5	ug/L
cis-1,2-Dichloroethene	5	0.6	ug/L
cis-1,3-Dichloropropene	5	0.5	ug/L
Dibromochloromethane	5	0.5	ug/L
Dichlorodifluoromethane	5	0.6	ug/L
Ethylbenzene	5	1	ug/L
Isopropyl ether	5	N/A	ug/L
Methylene chloride	5	0.4	ug/L
Methyl-tert-butyl-ether (MTBE)	5	0.3	ug/L
Styrene	5	0.5	ug/L
Tetrachloroethene	5	0.5	ug/L
Toluene	5	0.3	ug/L
trans-1,2-Dichloroethene	5	0.5	ug/L
trans-1,3-Dichloropropene	5	0.3	ug/L
Trichloroethene	5	0.7	ug/L
Trichlorofluoromethane	5	0.6	ug/L
Trichlorotrifluoroethane	5	0.5	ug/L
Vinyl acetate	5	0.2	ug/L
Vinyl chloride	5	0.8	ug/L
Xylenes (total)	5	1	ug/L

Table 7
Quantitation Limits for Soil Vapor and Ambeint Air
Greenpoint Energy Center
Brooklyn, New York

Analyte	CAS Number	Molecular Weight	Reporting Limit (ppbv)	Reporting Limit (µg/m3)
NYSDEC DER TO-15 TCL				
Benzene	71-43-2	78.11	0.20	0.64
Benzyl chloride	100-44-7	140.57	0.40	2.3
Bromodichloromethane	75-27-4	163.83	0.20	1.3
Bromoform	75-25-2	252.75	0.20	2.1
Bromomethane (Methyl bromide)	74-83-9	94.95	0.20	0.78
2-Butanone (Methyl ethyl ketone)	78-93-3	72.11	1.0	2.9
Carbon Tetrachloride	56-23-5	153.84	0.20	1.3
Chlorobenzene	108-90-7	112.56	0.20	0.92
Chloroethane	75-00-3	64.52	0.20	0.53
Chloroform	67-66-3	119.39	0.20	0.98
Chloromethane (Methyl chloride)	74-87-3	50.49	0.50	1
Cyclohexane	110-82-7	84.16	0.50	1.7
Dibromochloromethane	124-48-1	208.29	0.20	1.7
1,2-Dibromoethane	106-93-4	187.88	0.20	1.5
1,2-Dichlorobenzene	95-50-1	147.01	0.20	1.2
1,3-Dichlorobenzene	541-73-1	147.01	0.20	1.2
1,4-Dichlorobenzene	106-46-7	147.01	0.20	1.2
Dichlorodifluoromethane (Freon 12)	75-71-8	120.92	0.20	0.99
1,1-Dichloroethane	75-34-3	98.97	0.20	0.81
1,2-Dichloroethane	107-06-2	98.96	0.20	0.81
1,1-Dichloroethene	75-35-4	96.95	0.20	0.79
1,2-Dichloroethene (cis)	156-59-2	96.95	0.20	0.79
1,2-Dichloroethene (trans)	156-60-5	96.95	0.20	0.79
1,2-Dichloropropane	78-87-5	112.99	0.20	0.92
cis-1,3-Dichloropropene	10061-01-5	110.98	0.20	0.91
trans-1,3-Dichloropropene	10061-02-6	110.98	0.20	0.91
1,2-Dichlorotetrafluoroethane (Freon 114)	76-14-2	170.93	0.20	1.4
1,4-Dioxane	123-91-1	88.11	0.50	1.8
Ethanol *	64-17-5	46.07	0.20	0.38
Ethylbenzene	100-41-4	106.16	0.20	0.87
Hexachlorobutadiene	87-68-3	260.76	1.0	10.7
n-Hexane	110-54-3	86.18	0.50	1.8
Methylene Chloride	75-09-2	84.94	0.50	1.7
4-Methyl-2-pentanone (MIBK)	108-10-1	100.16	0.50	2
MTBE (Methyl tert-butyl ether)	1634-04-4	88.15	1.0	3.6
Styrene	100-42-5	104.14	0.20	0.85
Tertiary Butyl Alcohol (TBA)	76-65-0	74.12	2.00	6.1
1,1,2,2-Tetrachloroethane	79-34-5	167.86	0.20	1.4
Tetrachloroethene (PCE)	127-18-4	165.85	0.20	1.4
Toluene	108-88-3	92.13	0.20	0.75
1,2,4-Trichlorobenzene	120-82-1	181.46	1.0	7.4
1,1,1-Trichloroethane	71-55-6	133.42	0.20	1.1
1,1,2-Trichloroethane	79-00-5	133.42	0.20	1.1
1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	187.38	0.20	1.5
Trichloroethene (TCE)	79-01-6	131.4	0.20	1.1
Trichlorofluoromethane (Freon 11)	75-69-4	137.38	0.20	1.1
1,2,4-Trimethylbenzene	95-63-6	120.19	0.20	0.98
1,3,5-Trimethylbenzene	108-67-8	120.19	0.20	0.98
2,2,4-Trimethylpentane	540-84-1	114.23	0.50	2.3
Vinyl Chloride	75-01-4	62.5	0.20	0.51

Table 7
Quantitation Limits for Soil Vapor and Ambeint Air
Greenpoint Energy Center
Brooklyn, New York

Analyte	CAS Number	Molecular Weight	Reporting Limit (ppbv)	Reporting Limit (µg/m3)
Xylenes (m&p)	1330-20-7	106.16	0.20	0.9
Xylenes (o)	95-47-6	106.16	0.20	0.87
Compounds on National Grid Standard List, but not on NYSDEC DER TO-15 TCL				
Acetone (2-propanone)	67-64-1	58.08	5.0	12
Bromoethene	593-60-2	106.96	0.20	0.87
1,3-Butadiene	106-99-0	54.09	0.40	0.88
Carbon Disulfide	75-15-0	76.14	0.50	1.6
3-Chloropropene (allyl chloride)	107-05-1	76.53	0.20	0.63
2-Chlorotoluene	95-49-8	126.59	0.40	2.1
4-Ethyltoluene (p-ethyltoluene)	622-96-8	120.2	0.40	2.0
n-Heptane	142-82-5	101.2	0.50	2.1
Isopropyl Alcohol	67-63-0	61.09	2.0	5.0
Methyl Butyl Ketone	591-78-6	100.16	0.50	2.0
National Grid Supplemental Compound List				
n-Butane	106-97-8	58.12	0.40	1.0
n-Decane	124-18-5	142.29	1.0	5.8
n-Dodecane	112-40-3	170.34	1.0	7.0
n-Nonane	111-84-2	128.26	0.50	2.6
n-Octane	111-65-9	114.23	0.40	1.9
n-Pentane	109-66-0	72.15	1.00	3
n-Undecane	1120-21-4	156.31	1.00	6.4
1,2,3-Trimethylbenzene**	80-62-6	120.19	0.20	1.0
Naphthalene	91-20-3	128.17	0.50	2.6
1-Methylnaphthalene**	90-12-0	142.2	2.50	15
2-Methylnaphthalene**	91-57-6	142.2	2.50	15
Tetramethylbenzene*	25619-60-7	134.21	TBD	TBD
Indene**	95-13-6	116.16	0.40	1.9
Indane**	496-11-7	118.18	0.20	1.0
Thiophene**	110-02-1	84.14	0.20	0.7

Notes:

1. NYSDEC DER TO-15 TCL = New York State Department of Environmental Conservation (NYSDEC) Division of Environmental Remediation (DER) Target Compound List (TCL) as presented in Feb. 2008 "NYSDEC Modifications to EPA Region 9 TO-15 QA/QC Criteria."
2. Compounds on "National Grid Standard List" and "Supplemental Compound List" are from Tables 2 and 7 of the "draft" Standard Operating Procedures document titled "Soil Vapor Intrusion Evaluation at National Grid MGP sites in New York State", prepared by O'Brien & Gere, last updated September 2007.
3. Analyses to be performed by TestAmerica Laboratories, Inc. located in Knoxville,Tennessee using United States Environmental Protection Agency (USEPA) Compendium Method TO-15.
4. CAS = Chemical Abstract Services.
5. Molecular weights are presented in grams per mole.
6. ppbv = parts per billion volumetric basis.
7. µg/m3 = micrograms per cubic meter.
8. TBD = To be determined; reporting limit not available.
9. * = Compound to be included in laboratory analysis as a tentatively identified compound (TIC).10. ** = 1-point calibration.
10. ** = 1-point calibration.

Table 8
Soil Cleanup Objectives
Greenpoint Energy Center
Brooklyn, New York

Analytes	Unrestricted Use (ppm)	Residential Use (ppm)	Restricted-Residential Use (ppm)	Restricted-Commercial Use (ppm)	Restricted-Industrial Use (ppm)	Protection of Groundwater (ppm)	Protection of Ecological Resources (ppm)
Volatile Organic Compounds							
Acetone	0.05	100	100	500	1,000	0.05	2.2
Benzene	0.06	2.9	4.8	44	89	0.06	70
Butanone, 2-	0.12	100	100	500	1,000	0.12	100
Butylbenzene, n-	12	100	100	500	1,000	12	NE
Butylbenzene, tert-	5.9	100	100	500	1,000	5.9	NE
Butylbenzene,sec-	11	100	100	500	1,000	11	NE
Carbon tetrachloride	0.76	1.4	2.4	22	44	0.76	NE
Chlorobenzene	1.1	100	100	500	1,000	1.1	40
Chloroform	0.37	10	49	350	700	0.37	12
Dichlorobenzene,1,2-	1.1	100	100	500	1,000	1.1	NE
Dichlorobenzene,1,3-	2.4	17	49	280	560	2.4	NE
Dichlorobenzene,1,4-	1.8	9.8	13	130	250	1.8	20
Dichloroethane,1,1-	0.27	19	26	240	480	0.27	NE
Dichloroethane,1,2-	0.02	2.3	3.1	30	60	0.02	10
Dichloroethene, cis-1,2-	0.25	59	100	500	1,000	0.25	NE
Dichloroethene,1,1-	0.33	100	100	500	1,000	0.33	NE
Dioxane,1,4-	0.1	9.8	13	130	250	0.1	0.1
Ethylbenzene	1	30	41	390	780	1	NE
Methyl tert-butyl ether	0.93	62	100	500	1,000	0.93	NE
Methylene chloride	0.05	51	100	500	1,000	0.05	12
Naphthalene	12	100	100	500	1,000	12	NE
Propylbenzene, n-	3.9	100	100	500	1,000	3.9	NE
Tetrachloroethene	1.3	5.5	19	150	300	1.3	2
Toluene	0.7	100	100	500	1,000	0.7	36
Trans-1,2-dichloroethene	0.19	100	100	500	1,000	0.19	NE
Trichloroethane, 1,1,1-	0.68	100	100	500	1,000	0.68	NE
Trichloroethene	0.47	10	21	200	400	0.47	2
Trimethylbenzene, 1,2,4-	3.6	47	52	190	380	3.6	NE
Trimethylbenzene, 1,3,5-	8.4	47	52	190	380	8.4	NE
Vinyl chloride	0.02	0.21	0.9	13	27	0.02	NE
Xylene, total	0.26	100	100	500	1,000	1.6	0.26

Table 8
Soil Cleanup Objectives
Greenpoint Energy Center
Brooklyn, New York

Semi-Volatile Organic Compounds							
Acenaphthene	20	100	100	500	1,000	98	20
Acenaphthylene	100	100	100	500	1,000	107	NE
Anthracene	100	100	100	500	1,000	1,000	NE
Benz[a]anthracene	1	1	1	5.6	11	1	NE
Benzo[a]pyrene	1	1	1	1	1.1	22	2.6
Benzo[b]fluoranthene	1	1	1	5.6	11	1.7	NE
Benzo[g,h,i]perylene	100	100	100	500	1,000	1,000	NE
Benzo[k]fluoranthene	0.8	1	3.9	56	110	1.7	NE
Chrysene	1	1	3.9	56	110	1	NE
Dibenz[a,h]anthracene	0.33	0.33	0.33	0.56	1.1	1,000	NE
Dibenzofuran	7	14	59	350	1,000	210	NE
Fluoranthene	100	100	100	500	1,000	1,000	NE
Fluorene	30	100	100	500	1,000	386	30
Hexachlorobenzene	0.33	0.33	1.2	6	12	3.2	NE
Indeno[1,2,3-cd]pyrene	0.5	0.5	0.5	5.6	11	8.2	NE
Methylphenol, 4-	0.33	34	100	500	1,000	0.33	NE
Cresol, m (methylphenol, 3-)	0.33	100	100	500	1,000	0.33	NE
Methylphenol,2-	0.33	100	100	500	1,000	0.33	NE
Pentachlorophenol	0.8	2.4	6.7	6.7	55	0.8	0.8
Phenanthrene	100	100	100	500	1,000	1,000	NE
Phenol	0.33	100	100	500	1,000	0.33	30
Pyrene	100	100	100	500	1,000	1,000	NE
Pesticides							
Aldrin	0.005	0.019	0.097	0.68	1.4	0.19	0.14
Alpha-bhc	0.02	0.097	0.48	3.4	6.8	0.02	0.04
Alpha-chlordane	0.094	0.91	4.2	24	47	2.9	1.3
Beta-BHC	0.036	0.072	0.36	3	14	0.09	0.6
DDD,4,4-	0.0033	2.6	13	92	180	14	0.0033
DDE,4,4-	0.0033	1.8	8.9	62	120	17	0.0033
DDT,4,4-	0.0033	1.7	7.9	47	94	136	0.0033
Delta-BHC	0.04	100	100	500	1,000	0.25	0.04
Dieldrin	0.005	0.039	0.2	1.4	2.8	0.1	0.006
Endosulfan I	2.4	4.8	24	200	920	102	NE
Endosulfan II	2.4	4.8	24	200	920	102	NE
Endosulfan sulfate	2.4	4.8	24	200	920	1,000	NE
Endrin	0.014	2.2	11	89	410	0.06	0.014
Gamma-BHC	0.1	0.28	1.3	9.2	23	0.1	6
Heptachlor	0.042	0.42	2.1	15	29	0.38	0.14
Silvex	3.8	58	100	500	1,000	3.8	NE
Polychlorinated Biphenyls (PCBs)							
Total PCBs	0.1	1	1	1	25	3.2	1

Table 8
Soil Cleanup Objectives
Greenpoint Energy Center
Brooklyn, New York

Total Metals							
Arsenic	13	16	16	16	16	16	13
Barium	350	350	400	400	10,000	820	433
Beryllium	7.2	14	72	590	2700	47	10
Cadmium	2.5	2.5	4.3	9.3	60	7.5	4
Chromium (VI)	1	22	110	400	800	19	1
Chromium (III)	30	36	180	1500	6800		41
Copper	50	270	270	270	10,000	1720	50
Lead	63	400	400	1000	3900	450	63
Manganese	1600	2000	2,000	10,000	10,000	2,000	1600
Mercury	0.18	0.81	0.81	2.8	5.7	0.73	0.18
Nickel	30	140	310	310	10,000	130	30
Selenium	3.9	36	180	1500	6800	4	3.9
Silver	2	36	180	1500	6800	8.3	2
Zinc	109	2200	10,000	10,000	10,000	2480	109
Cyanide							
Cyanide, Total	27	27	27	27	10,000	40	NE

Note:
ppm - parts per million

Table 9
Groundwater Standards, Criteria and Guidance
Greenpoint Energy Center
Brooklyn, New York

	Standard and Guidance Value Health (Water Source)	Standard and Guidance Value Aesthetic
Metals by EPA Method 6000/7000 series		
Aluminum	NE	NE
Antimony	3	NE
Arsenic	25	NE
Barium	1000	NE
Beryllium	3*	NE
Boron	1000	NE
Cadmium	5	NE
Calcium	NE	NE
Chromium	50	NE
Cobalt	NE	NE
Copper	200	NE
Iron	ND	300
Lead	25	NE
Magnesium	35000*	NE
Manganese	ND	300
Mercury	0.7	NE
Nickel	100	NE
Potassium	NE	NE
Selenium	10	NE
Silica	NE	NE
Silver	50	NE
Sodium	20000	NE
Thallium	0.5*	NE
Tin	NE	NE
Titanium	NE	NE
Vanadium	NE	NE
Zinc	2000*	ND
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270C		
1,2,4-Trichlorobenzene	5	NE
1,2-Dichlorobenzene	3	NE
1,2-Diphenylhydrazine	NE	NE
1,3-Dichlorobenzene	3	NE
1,4-Dichlorobenzene	3	NE
2,2-oxybis (1-chloropropane)	NE	NE
2,4,5-Trichlorophenol	NE	1
2,4,6-Trichlorophenol	NE	1
2,4-Dichlorophenol	5	NE
2,4-Dimethylphenol	50*	NE
2,4-Dinitrophenol	10*	NE
2,4-Dinitrotoluene	5	NE
2,6-Dinitrotoluene	5	NE
2-Chloronaphthalene	NE	NE
2-Chlorophenol	NE	1
2-Methylnaphthalene	NE	NE
2-Methylphenol	NE	1
2-Nitroaniline	5	NE
2-Nitrophenol	NE	1

Table 9
Groundwater Standards, Criteria and Guidance
Greenpoint Energy Center
Brooklyn, New York

	Standard and Guidance Value Health (Water Source)	Standard and Guidance Value Aesthetic
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270C (Continued)		
3,3-Dichlorobenzidine	NE	NE
3-Nitroaniline	5	NE
4,6-Dinitro-2-methylphenol	NE	NE
4-Bromophenyl phenyl ether	NE	NE
4-Chloro-3-methylphenol	NE	1
4-Chloroaniline	5	NE
4-Chlorophenyl phenyl ether	NE	NE
4-Methylphenol	NE	1
4-Nitroaniline	5	NE
4-Nitrophenol	NE	1
Acenaphthene	NE	20*
Acenaphthylene	NE	NE
Acetophenone	NE	NE
Aniline	5	NE
Anthracene	50*	NE
Benzaldehyde	NE	NE
Benzidine	NE	NE
Benzo(a)anthracene	0.002*	NE
Benzo(a)pyrene	NE	NE
Benzo(b)fluoranthene	0.002*	NE
Benzo(ghi)perylene	0.002*	NE
Benzo(k)fluoranthene	0.002*	NE
Benzoic acid	NE	NE
Benzyl alcohol	NE	NE
Biphenyl	NE	1
Bis(2-chloroethoxy)methane	NE	NE
Bis(2-chloroethyl)ether	1	NE
Bis(2-ethylhexyl)phthalate	5	NE
Butyl benzyl phthalate	50*	NE
Caprolactam	NE	NE
Carbazole	NE	NE
Chrysene	0.002*	NE
Dibenzo(a,h)anthracene	NE	NE
Dibenzofuran	NE	NE
Diethyl phthalate	50*	NE
Dimethyl phthalate	50*	NE
Di-n-butyl phthalate	50	NE
Di-n-octyl phthalate	50*	NE
Fluoranthene	50*	NE
Fluorene	50*	NE
Hexachlorobenzene	0.04	NE
Hexachlorobutadiene	0.5	NE
Hexachlorocyclopentadiene	NE	NE
Hexachloroethane	NE	NE
Indeno(1,2,3-cd)pyrene	0.002*	NE
Isophorone	50*	NE
Naphthalene	NE	10*
Nitrobenzene	0.4	NE

Table 9
Groundwater Standards, Criteria and Guidance
Greenpoint Energy Center
Brooklyn, New York

	Standard and Guidance Value Health (Water Source)	Standard and Guidance Value Aesthetic
Semivolatile Organic Compounds (SVOCs) by EPA Method 8270C (Continued)		
n-Nitroso-di-n-propylamine	NE	NE
n-Nitrosodiphenylamine	NE	NE
n-Nitrosomethylethylamine	NE	NE
Pentachlorophenol	NE	1
Phenanthrene	50*	NE
Phenol	NE	1
Pyrene	50*	NE
Pyridine	NE	NE
Volatile Organic Compounds (VOCs) by EPA Method 8260B		
1,1,1-Trichloroethane	5	NE
1,1,2,2-Tetrachloroethane	5	NE
1,1,2-Trichloroethane	1	NE
1,1-Dichloroethane	5	NE
1,1-Dichloroethene	5	NE
1,2,3-Trichloropropane	0.04	NE
1,2,4-Trichlorobenzene	5	NE
1,2-Dibromo-3-chloropropane	NE	NE
1,2-Dibromoethane	NE	NE
1,2-Dichlorobenzene	3	NE
1,2-Dichloroethane	0.6	NE
1,2-Dichloropropane	1	NE
1,3-Dichlorobenzene	3	NE
1,3-Dichloropropane	5	NE
1,4-Dichlorobenzene	3	NE
2-Butanone (MEK)	50*	NE
2-Chloroethylvinylether	NE	NE
2-Hexanone	NE	NE
4-Methyl-2-pentanone (MIBK)	NE	NE
Acetone	50*	NE
Acrolein	NE	NE
Acrylonitrile	NE	NE
Benzene	1	NE
Bromodichloromethane	50*	NE
Bromoform	NE	NE
Bromomethane	5	NE
Carbon disulfide	NE	NE
Carbon tetrachloride	5	NE
Chlorobenzene	5	NE
Chloroethane	5	NE
Chloroform	7	NE
Chloromethane	5	NE
Cyclohexane	NE	NE
cis-1,2-Dichloroethene	5	NE
cis-1,3-Dichloropropene	0.4	NE
Dibromochloromethane	50	NE
Dichlorodifluoromethane	NE	NE
Ethylbenzene	5	NE
Isopropylbenzene	5	NE
Isopropyl ether	NE	NE

Table 9
Groundwater Standards, Criteria and Guidance
Greenpoint Energy Center
Brooklyn, New York

	Standard and Guidance Value Health (Water Source)	Standard and Guidance Value Aesthetic
Volatile Organic Compounds (VOCs) by EPA Method 8260B (Continued)		
Methylene chloride	5	NE
Methyl acetate	NE	NE
Methylcylohexane	NE	NE
Methyl-tert-butyl-ether (MTBE)	NE	NE
Styrene	5	NE
Tetrachloroethene	5	NE
Toluene	5	NE
trans-1,2-Dichloroethene	5	NE
trans-1,3-Dichloropropene	0.4	NE
Trichloroethene	5	NE
Trichlorofluoromethane	NE	NE
Trichlorotrifluoroethane	5	NE
Vinyl acetate	NE	NE
Vinyl chloride	2	NE
Xylenes (total)	5	NE
Herbicides by EPA Method 8151A		
2,4-D	50	NE
2,4,5-TP (Silvex)	NE	NE
2,4,5-T	35	NE
Pesticides by EPA Method 8082A		
4,4'-DDD	0.3	NE
4,4'-DDE	0.2	NE
4,4'-DDT	0.2	NE
Aldrin	NE	NE
alpha-BHC	0.01	NE
alpha-Chlordane	0.05	NE
beta-BHC	0.04	NE
delta-BHC	0.04	NE
Dieldrin	0.004	NE
Endosulfan I	NE	NE
Endosulfan II	NE	NE
Endosulfan sulfate	NE	NE
Endrin	NE	NE
Endrin aldehyde	NE	NE
Endrin ketone	NE	NE
gamma-BHC (Lindane)	0.05	NE
gamma-Chlordane	0.05	NE
Heptachlor	0.04	NE
Heptachlor epoxide	0.03	NE
Methoxychlor	35	NE
Toxaphene	NE	NE
Total Cyanide by EPA Method 9012A		
Cyanide, Total	200	NE

Notes:
All units micrograms per liter
NE - Not estblished
* - Guidance Value

Appendix A

Laboratory Quality Manual (electronic only)

SEVERN TRENT LABORATORIES - CONNECTICUT
LABORATORY QUALITY MANUAL
Revision: 6

128 Long Hill Cross Road
Shelton, Connecticut 06484
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Approved by:

Peter Frick, Laboratory Director — Date: March 22, 2005

Marsha K. Culik, Quality Assurance Manager — Date: March 22, 2005

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1. Introduction, Purpose, and Scope

1.1. Severn Trent Laboratories (STL) Overview

Severn Trent Plc is a leading environmental services group providing water, waste and utility services. The businesses include Severn Trent Water, Biffa, Severn Trent Laboratories (STL) and Severn Trent Services.

The corporate vision is to be at the forefront of the environmental services industry. The corporate values of environmental leadership, service and quality define the business culture and strategic direction.

STL offers a broad range of environmental testing services provided by over two thousand professionals in the US. STL's testing capabilities include chemical, physical, and biological analyses of a variety of matrices, including aqueous, solid, drinking water, waste, tissue, air and saline/estuarine samples. Specialty capabilities include air toxics, radiological testing, tissue preparation and analysis, aquatic toxicology, microbiology, Mycology, asbestos, microscopy services, and on-site technologies including mobile laboratory services.

This plan is intended to describe the quality assurance program of the STL-Connecticut facility located at 128 Long Hill Cross Roads, Shelton, Connecticut. STL operates a corporate wide quality assurance program and this facility QA program complies with the requirements set forth in the corporate program.

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 objective, 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 and ensures data integrity.

1.3. Management Commitment to Quality Assurance

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

STL Vision and Mission Statement

Vision

STL will be the recognized industry leader for environmental analysis.

Mission

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 the profitable growth of our business.

1.4. Purpose

The purpose of this Laboratory Quality Manual (LQM) is to describe the STL-Connecticut Quality System and to outline how that system enables all employees of STL-Connecticut 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. In some cases, the requirements in the facility QA program may be more stringent than the corporate program, but in no case can they be less stringent.

1.5. Scope

The requirements set forth in this document are applicable to the STL-Connecticut quality systems and laboratory operations.

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

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)
New York State Department of Environmental Conservation (NYSDEC)
National Pollution, Discharge, and Elimination System (NPDES, NJPDES)
Resource Conservation and Recovery Act (RCRA)
Safe Drinking Water Act (SDWA)
US Army Corps of Engineers, Hazardous, Toxic and Radioactive Waste (USACE HTRW)

STL also provides services under various state and local municipal guidelines. A current list of Analytical Services and certifications can be provided by the laboratory or viewed on the MySTL webpage at www.MySTL-inc.com.

This QMP was written to comply with the National Environmental Laboratory Accreditation Conference (NELAC) standards and the STL corporate Quality Management Plan, M-Q-001.

1.6 **Servicing**

Project Managers are the direct client contact and they ensure resources are available to meet project requirements. Although Project Managers do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project Managers provide a link between the client and laboratory resources.

The laboratory has established procedures for performing and verifying that client servicing meets requirements. Typical services provided are:

- Sample Containers/Supplies – *Container Management: Process Operation* (VCM-001)
- Project QAP preparation – *Project Planning Process* (VPM-002)
- Regulatory advisory functions – *Project Planning Process* (VPM-002)
- Consulting -- *Project Planning Process* (VPM-002)

Regulatory and advisory functions are addressed under the same procedures used for project planning.

2. *References*

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

EPA Requirements For Quality Management Plans, EPA QA/R-2, United States Environmental Protection Agency Management Staff, Washington, DC, Draft Interim Final, March 2001.

EPA Quality Manual for Environmental Programs, 5360, US EPA Office of Research and Development, National Center for Environmental Research and Quality Assurance, Quality Assurance Division, July 1998.

Good Automated Laboratory Practices, EPA 2185, 1995.

National Environmental Laboratory Accreditation Conference, Constitution, Bylaws, and Standards, EPA600/R-98/151, US EPA Office of Research and Development, July 2000.

Shell for Analytical Chemistry Requirements, US Army Corps of Engineers, 2001.

DOD Quality Systems manual (QSM) for Environmental Laboratories, Version 2

3. *Terms and Definitions*

Accuracy: the degree of agreement between an observed value and an accepted reference 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 the same 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 (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 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 based on program, matrix, analyte.

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 and still be considered valid as promulgated in the method.

Initial Demonstration of Capability (IDC): procedure to establish the ability to generate acceptable accuracy and precision. Also referred to as Initial Demonstration of Proficiency.

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 on specific instrument, with a specified degree of confidence that the amount is greater than zero. The IDL is associated with the instrumental portion of a specific method only, and specific sample preparation steps are not considered in its derivation.

A calculated IDL, by definition, has an uncertainty of +100% with 99% confidence, and is the point at which the possibility of detection of false negatives is 50 % and false positives is 1%. The IDL thus represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

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

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. (see MDL)

Matrix: The substrate of a test sample. For purposes of batch and QC requirements determination, the matrix descriptions in Table 1 are used.

Table 1 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.

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 method. An MDL, by definition, has an uncertainty of +100% with 99% confidence, and is the point as which the possibly of detection of false negative is 50% and false positive is 1%. The MDL thus represents a range where qualitative detection occurs using a specific method. Quantitative results are not produced in this range. Also referred to as Limit of Detection.

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

Precision: the degree to which a set of observations or measurements of the same property, usually obtained under similar conditions, conform to themselves; a data quality indicator.

Preservation: refrigeration and or reagents added at the time of sample collection to maintain the chemical 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 whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

Quality Control Sample: an uncontaminated sample matrix spiked with a known amount(s) of an analyte(s) from a source independent from the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

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 lowest point at which a substance can be quantitatively measured with a specified degree of confidence using a specific method. 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 a Practical Quantitation Level (PQL), Estimated Quantitation Level (EQL), or Limit of Quantitation (LOQ).

Raw Data: any original information from a measurement activity or study recorded in a laboratory notebook, 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 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 report 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 method or instrument to respond to a target substance or constituent in the presence of non-target substances.

Sensitivity: the capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.

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.

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.

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

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

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.

Verification: confirmation by examination and provision of evidence that specified requirements have been met.

4. Management Requirements

4.1. Organization and Management

4.1.1. Organization

The STL-Connecticut organizational structure is presented on the organizational chart as outlined in the appendix. A QA Manager is designated at the STL facility and reports to the Laboratory Director. The facility QA Manager has an indirect reporting relationship to the Corporate QA Director.

4.1.2. Roles and Responsibilities

President

The President of STL, Inc. has overall management responsibility and authority for Severn Trent's laboratory division, including responsibility for budgeting, resource allocation, long term planning, sales, marketing, and final approval on all management and administrative policies and management plans. The President authorizes the STL Corporate LQM and as such, sets the standards for the Quality System.

Chief Operating Officer (COO)
The COO is responsible for daily management of all STL facilities. The COO's responsibilities include allocation of personnel and resources, long term planning, and development of technical policies and management plans. The COO authorizes the STL Corporate LQM and is responsible for ensuring that business operations are conducted in accordance with its requirements.

Vice President Client and Operations Services (VP COS)
The VP of Operations Services is responsible for all essential elements of offerings to clients, including risk management, legal compliance and contract administration, quality assurance, information technology, and environmental health and safety. The VP COS authorizes the QMP and responsibilities include authorization of Manuals, Policies and Procedures, providing support and direction to the Managers of these areas, and supporting the COO in decisions regarding long term planning, resource allocation, and capital expenditures.

QA Director
The QA Director is responsible for establishing, implementing and communicating STL's quality system. The QA Director monitors compliance with the QMP, provides regulatory and technical updates to the STL facilities, assists in development of management plans and technical policies to be approved by the COO, and coordinates training within STL. The QA Director is available to any employee in STL to resolve data quality or ethical issues. The QA Director is independent of operational functions.

Director of Technical Services
The Director of Technical Services is responsible for establishing, implementing and communicating STL's Technical Policies, Standard Operating Procedures, and Manuals. Other responsibilities include conducting technical assessments as required, acting as a technical resource in national contracts review, coordinating new technologies, establishing best practices throughout STL, advising STL staff on technology advances, innovations, and applications, and organizing and running STL's technical committee.

Chief Information Officer (CIO)
The CIO is responsible for establishing, implementing and communicating STL's IT Policies, Standard Operating Procedures, and Manuals. Other responsibilities include coordinating new technologies, development of electronic communication tools such as STL's intranet and internet sites, ensuring data security and documentation of software, ensuring compliance with Good Automated Laboratory Practices (GALP), and assistance in establishing, updating, and maintaining Laboratory Information Management Systems (LIMS) at the various STL facilities.

Environmental Health and Safety (EH&S) Director
The Health and Safety Coordinator is responsible for the safety and well-being of all employees while at the laboratory. This includes, but is not limited to, administering the Corporate Safety Manual that complies with federal regulations, MSDS training and review, conducting laboratory safety orientation and tours for all new employees, providing instructions on safety equipment, cleaning up laboratory spills, and instructing personnel of laboratory procedures for emergency situations. The Health and Safety Coordinator is on-call 24-hours a day, 7-days a week for all laboratory situations.

The Health and Safety Coordinator responsibilities additionally include waste management of laboratory generated hazardous waste in accordance with appropriate regulations. This includes maintenance of required documentation, such as waste manifests, segregation of waste in accordance with requirements, and training of personnel in proper segregation of waste and preparation of Safety related SOPs.

General Manager (GM)
The GM 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 systems reviews.

Laboratory Director
The Laboratory Director oversees the daily operations of the laboratory. The Laboratory Director's responsibilities include supervision of staff, setting goals for the employees, and achieving the financial, business, and quality objectives of the facility. The Laboratory Director is to maintain technical understanding of analytical methodology for

the laboratory operations, development of procedural improvements and investigation of non-conformances.

QA Manager

The Quality Assurance Manager (QAM) has the full-time responsibility to evaluate the adherence to policies and to assure that systems are in place to produce the level of quality defined in this LQM. The QAM is responsible for:

- Ensures IDL/MDL studies are completed and documented
- Ensures method validation studies are completed and documented
- Periodically performs data package inspections
- Performs data authenticity audits on 100% of analysts and instruments
- Assist in the preparation, compilation, and submittal of quality assurance project plans
- Reviews program plans for consistency with organizational and contractual requirements and advises appropriate personnel of deficiencies
- Maintains QA records
- Maintains certifications and accreditations
- Initiates and oversees both internal and external audits; documents root cause investigations for all noted deficiencies; and ensures timely audit closure
- Maintains a corrective action process for internally identified issues and ensures timely closure
- Manages the laboratory's PT Program and performs/documents root cause investigations for all failures
- Monitors to ensure the documentation of training and method demonstration are current
- Facilitates SOP development and document control

The QA Manager shall have 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 available to any employee at the facility to resolve data quality or ethical issues. The QA Manager shall be independent of laboratory operations and has an indirect reporting relationship to the QA Director.

Project Managers

The laboratory recognizes the importance of efficient project management. The laboratory Project Managers (PM) are responsible for preparing the project technical profile which summarizes QA/QC requirements for the project, maintaining the laboratory schedule, communicating technical requirements to the laboratory, and advising the Laboratory, QA and Technical Managers of all variances. The laboratory Project Manager will provide technical guidance and the necessary laboratory-related information to the preparer of project-specific QAPPs and provide peer review of the final document to ensure accuracy of the laboratory information.

Technical Managers (Laboratory Departmental Group Leader/Supervisor)

The Laboratory Supervisor oversees the daily operations of their particular laboratory department. The supervisor's responsibilities include supervision of staff, setting goals and objectives for their employees, and achieving the business and quality objectives of the facility.

4.2. Quality System

4.2.1. Objectives of STL-Connecticut Quality System

The goal of the STL-Connecticut 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 scientifically sound, well documented, regulatory compliant data, and to ensure that we provide the highest quality service available in the industry with uncompromising data integrity. A well-structured, organized and 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 provides a framework for continuous improvement.

This LQM, Work Instructions and the SOPs are the basis and outline for our quality and data integrity system and contain requirements and general guidelines under which the laboratory conducts operations. In addition, other documents may be used by the laboratory to clarify compliance with quality system or other client requirements. Within the LQM, SOP or Work Instruction numbers are noted in parenthetic text. These numbers refer to the laboratory procedure(s) associated with the subject item. A table listing these quality system policies and procedures is appended to this document.

The QA Manager is responsible for implementing and monitoring the Quality System. The QA Manager reports to the Laboratory Director on the performance of the quality system for review and continuous improvement. The QA Manager has sufficient authority, access to work areas, and organizational freedom (including sufficient independence from cost and schedule considerations) to:

- Initiate action to prevent the occurrence of any nonconformities related to product, process and quality system,
- Identify and record any problems affecting the product, process and quality system,
- Initiate, recommend, or provide solutions to problems through designated channels,
- Verify implementation of solutions, and
- Assure that further work is stopped or controlled until proper resolution of a non-conformance, deficiency, or unsatisfactory condition has occurred and the deficiency or unsatisfactory condition has been corrected.

The QA Manager identifies opportunities for continual improvement. When a situation arises where acceptable resolution of identified issues cannot be agreed upon at the laboratory, direct access to STL's Corporate Quality Director is available. This provides laboratory QA personnel independence, where needed, to ensure that QA policies and procedures are enforced.

The Laboratory Quality Manual is the basis and outline for the STL-Connecticut Quality System and contains guidelines under which the STL-Connecticut facility conducts operations in accordance with the STL Corporate Quality Management Plan (QMP).

4.2.2. Laboratory Quality Manual (LQM)

The following elements are addressed in the STL-Connecticut facility's LQM:

1. Table of Contents, lists of references and glossaries, and appendices.
2. Quality policy statement, including objectives and commitments, by facility management.
3. Organization and management structure of the laboratory, its place in the STL organization and relevant organizational charts.
4. Relationship between management, technical operations, support services and the quality system.
5. Record retention procedure.
6. Document control procedure.
7. Job descriptions of essential staff and reference to job descriptions of other staff.
8. Identification of the laboratory's approved signatories.
9. Procedure for achieving traceability of measurements.
10. List of test methods under which the laboratory performs its testing.
11. Procedure for reviewing new work.
12. Reference to the calibration and/or verification test procedures used.
13. Sample handling procedure.
14. Reference to the major equipment, reference standards, facilities and services used by the laboratory in conducting tests.
15. Reference to procedures for calibration, verification and maintenance of equipment.
16. Reference to verification practices including inter-laboratory comparisons, proficiency testing programs, use of reference materials and internal QC practices.
17. Procedures for feedback and corrective action when testing discrepancies are detected, or departures from policies and procedures occur.
18. Procedure for exceptionally permitting departures from documented policies and procedures or from standard specifications.
19. Procedure for dealing with client complaints.
20. Procedure for protecting client confidentiality and proprietary rights.
21. Procedure for audits and data review.

22. Procedure for establishing that personnel are adequately experienced and trained.
23. Reference to procedures for reporting analytical results.

4.3. Document Control

A system of document control is essential to provide the framework necessary to ensure that methods and procedures are followed in a consistent manner.

The STL-Connecticut laboratory has developed a centralized document control system and is administered by the QA department. The document control system provides for the following:

- A unique document control number for each document
- A central location for all documents
- A systematic method for distribution of approved documents
- A tracking system for existing documents
- Identification of document revisions
- A mechanism for periodic review of documents
- Archival of outdated material
- A focal point for information exchange
- Facilitates the establishment of standardized methods and procedures

4.3.1. 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, Effective Date, Number of Pages. Controlled documents are authorized by Management and/or the QA Department. Controlled documents are marked as such and records of their distribution are kept by the QA Department. Controlled documents, such as SOPs will be stamped in red with "Controlled Document #". If this writing is not in red, then that copy will not be considered a controlled document.

4.3.2. Document Revision

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 are replaced with the current version of the document. The previous revision of the controlled document is archived by the QA Department. Laboratory SOPs and quality documents are required to be reviewed annually and updated as needed.

A detailed description of the document control system is contained in STL-Connecticut SOP for Document Control. This document is available for inspection and review during a site visit. The Quality Assurance Manager is responsible for ensuring that the document control system is properly managed. Any new or revised document must be submitted to the QA Manager for review and distribution.

4.4. Request, Tender, and Contract Review

4.4.1. 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 STL's intent to provide both standard and customized environmental laboratory services to our clients. To ensure project success, technical staff perform a thorough review of technical and QC requirements contained in contracts. Contracts are reviewed for adequately defined requirements and STL'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 STL representative 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 are reviewed and approved by the appropriate personnel at the facility or facilities performing the work. Any contract requirement or amendment to a contract communicated to STL verbally is documented and confirmed with the client in writing. Any discrepancy between the client's requirements and STL's capability to meet those requirements is resolved in writing before acceptance of the contract. Contract amendments, initiated by the client and/or STL, are documented in writing for the benefit of both the client and STL.

All contracts, Quality Assurance Project Plans (LQMPs), Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the permanent project record as defined in Section 4.12.1.

4.4.2. 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, STL assigns 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. The labnet LIMS system used at STL-CT requires that project information be entered prior to samples being logged into the laboratory.

The STL - Connecticut facility has established many procedures in order to ensure that communication is inclusive and effective. These include project memos, designation and meetings of project teams, and meetings between the laboratory staff and the client. STL has found it very effective to invite the client into this process. STL strongly encourages our clients to visit the laboratories and hold formal or informal sessions with employees in order to effectively communicate client needs on an ongoing basis, as well as project specific details for customized testing programs.

4.4.3. 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.

The components of analytical variability (uncertainty) can be estimated when QC samples of the right types and at the appropriate frequency are incorporated into measurement process at the analytical laboratory. STL incorporates numerous QC samples to obtain data for comparison with the analytical DQOs and to ensure that the measurement system is functioning properly. The QC samples and their applications, described in Section 5.8.2, are selected based on regulatory, method- or client-specific requirements. Analytical laboratory QC samples for inorganic, and organic analyses may include calibration blanks, instrument blanks, method blanks, LCS, calibration standards, MS, MSD, and surrogate spikes.

The DQOs discussed below ensure that data are gathered and presented in accordance with procedures appropriate for its intended use, 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.

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.

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 95% 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. Only data of known quality such as precision and bias be readily compared. 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.

4.5. Subcontracting

STL Connecticut may find the need to send selected analyses to a subcontract laboratory either within the STL network or outside of the STL organization. The most common reason for utilization of a subcontract facility is that the procedure is not routinely

performed by the STL Connecticut laboratory and the subcontractor has greater experience in day-to-day execution of the method. All subcontract laboratories utilized by STL on a continuing basis require approval of the QA department prior to use, either on a corporate level or locally.

Subcontracting is arranged with the documented consent of the client, in a timely response which shall not be unreasonably refused. 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. Proof of required certifications from the subcontract facility are maintained in STL project records. Where applicable, specific QC guidelines, LQMPs, and/or SAPs are transmitted to the subcontract laboratory. Samples are subcontracted under formal Chain of Custody (COC).

Subcontract laboratories may receive an on-site audit by a representative of the STL network'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.

Project reports from external subcontract laboratories are not altered and are included in original form in the final project report provided by STL.

Subcontracting may also occur between STL facilities. Subcontracting within STL is subject to the same requirements as detailed above.

4.6. 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. A list of current vendors used by the lab is on file with the QA dept along with any documented quality issues.

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Purchasing guidelines for equipment and reagents meet with the requirements of the specific method and testing procedures for which they are being purchased. Solvents and Acids are pretested in accordance with the SOP, S-T-001, Testing Solvents and Acids, at a predefined STL laboratory. Documentation of lot certification is communicated to the QAMs and posted on the STL intranet.

4.6.1 Solvent and Acid Lot Verification

Pre-purchase approval is performed for solvents and acids purchased in large quantities unless a certificate of conformance has been furnished. These may include acetone, ethyl ether, hexane, methylene chloride, nitric acid, hydrochloric acid, sulfuric acid, and hydrogen peroxide. Each lot of incoming supplies requiring pre-approval is checked against the previously approved lot number. If the lot number is not approved, the lot is refused. If the lot number is an approved lot number, it is accepted and documented. Solvents and acids are pre-tested in accordance with STLs Corporate *Testing Solvents and Acids* procedure (S-T-001) for all of the STL laboratories. A Certificate of Analysis is requested for all standards and reagents as applicable and kept on file at the laboratory.

4.7. Service to the Client

Each client is assigned a Project Manager . The PM is the focal point for setting up projects, placing bottle orders, reviewing sample receipts, monitoring jobs within the lab, communicating any analytical issues and reviewing the final report.

4.7.1. Sample Acceptance Policy

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 is documented in the project records and the client is contacted for instructions. If the client decides to proceed with analysis, the project report will clearly indicate any of the above conditions and the resolution.

4.7.2. 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.

4.8. Complaints

STL believes that effective client complaint handling processes have important business and strategic value. Listening to and documenting client's concerns captures 'client knowledge' that helps to continually improve processes and outpace the competition. Implementing a client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

Client complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly. Client complaints are documented by the employee receiving the complaint. The documentation can take the form of a corrective action report (as described in Section 4.10) or in a format specifically designed for that purpose. The Laboratory Director, PM, Customer Service Manager, and QA Manager are informed of all client complaints, and assist in resolving the complaint.

The nature of the complaint is identified, documented, and 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 is required to 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.

The number and nature of client complaints is reported to the Corporate QA Manager in the QA Monthly report submitted by each facility. The overall number of complaints received per facility is tracked and the appropriateness of the response to client complaints is assessed. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Management Systems Review.

4.9. Control of Non-conformances

Non-conformances include any out of control occurrence. Non-conformances may relate to client specific requirements, procedural requirements, or equipment issues. All non-conformances in the laboratory are 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 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 is 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.

4.10. Corrective Action

4.10.1. General

The STL-Connecticut facility has an established, documented corrective action process. 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.

All corrective actions, whether immediate or long-term, will comprise the following steps to ensure a closed-loop corrective action process:

- Define the problem.
- Assign responsibility for investigating the problem.
- Determine a corrective action to eliminate the problem.
- Assign, and obtain commitment to, responsibility for implementing the corrective action.
- Implement the correction.
- Assess the effectiveness of the corrective action and verify that the corrective action has eliminated the problem.

4.10.1.1 Immediate Corrective Action

Immediate corrective actions to correct or repair non-conforming equipment and systems are generally initiated in response to adverse conditions identified through QC procedures. The analyst has relatively quick feedback that a problem exists, e.g., calibration does not meet or QC check samples exceed allowable criteria, and can take immediate action to repair the system.

The initial responsibility to monitor the quality of a function or analytical system lies with the individual performing the task or procedure. DQOs are evaluated against laboratory-established or against method or client specified QA/QC requirements. If the assessment reveals that any of the QC acceptance criteria are not met, the analyst must immediately assess the analytical system to correct the problem. When the appropriate corrective action

measures have been defined and the analytical system is determined to be "in-control" or the measures required to put the system "in-control" have been identified and scheduled, the problem and resolution or planned action is documented in the appropriate logbook or NCM. Data generated by an analytical system that is determined to be out-of-control must never be released without approval of the Section Manager, QA Manager, Laboratory Director and client notification.

4.10.1.2 Long-term Corrective Action

Long-term corrective action is generally initiated due to QA issues, which are most often identified during internal and external audits. Typically, a deeper investigation into the root cause of the nonconformance is warranted, and the problem may take much longer to identify and resolve. Staff training, method revision, replacement of equipment, and LIMS reprogramming are examples of long-term corrective action.

4.10.2. Initiation

Any employee in STL is authorized to initiate a corrective action. The initial source of corrective action can also be external to STL (i.e. corrective action because of client complaint, regulatory audit, or proficiency test). When a problem that requires corrective action is identified, the following items are identified by the initiator on the corrective action report: 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.

4.10.3. Cause analysis

The corrective action process must be embarked upon as a joint, problem solving and 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.

4.10.4. Corrective Action

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.

Implementation of the corrective action and the date of implementation are documented on the corrective action report.

Copies of the corrective action form are given to the appropriate department(s) and, if related to a specific project report, 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.

4.10.5. Monitoring Corrective Action

All corrective action reports are forwarded to the QA Department. The QA department reviews all corrective actions and selects one or more of the more 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.

4.11. Preventative 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. The preventative action process takes the same format as the corrective action process.

4.12. Records

It is the responsibility of all members of the laboratory to maintain complete records of all operations performed. All records shall be neat and organized. All laboratory records are the property of the laboratory and shall not be removed from the premises without permission from supervisors. All records are considered confidential and must be safeguarded. Unauthorized changes, loss or destruction of records can be grounds for dismissal from the laboratory. Consult the Severn Trent Laboratories Ethics Policy regarding integrity of data and employee conduct.

Measurement records must be recorded in pre-printed electronic record logs or pre-printed measurement logs. This policy will facilitate the organization and archival of all laboratory data for future reference. In some departments records maybe kept electronically using the labnet LIMS system. This may include standard prep, reagent prep or sample prep. Electronic records are backed up and safeguarded as per STL's IT policies.

All injection forms, instrumentation forms, sample prep forms, QC forms, etc. which are used to process samples and measurement results are described and attached to each analytical SOP. The SOP specifies where these records and forms are cataloged and stored.

All measurement data is recorded in pre-numbered, bound, logbooks in permanent ink. Transcriptions will be avoided whenever possible. The record will reflect the measurement performed and all appropriate details for conclusions related to the measurement. The record must be initialed and dated by the individual performing the measurement on the day the measurement is performed. Corrections shall be made by drawing a single line through the error, initialing and dating the error. All forms will be reviewed by the QA Manager annually. If it is found that the document does not meet the requirements of the SOP, the discrepancy is forwarded to the group/section leader through the corrective action process (reference SOP on Corrective Action Reports). Further detail on laboratory document control is found in the SOP on Document Control.

4.12.1. Record Types

Record types are described in Table 2.

Table 2 STL Record Types

Raw Data	Controlled Documents	QC Records	Project Records	Administrative Records
Calibration	LQM	Audits/ Responses	COC Documentation	Accounting
Computer Tapes/Disks	LQM	Certifications	Contracts and Amendments	EH&S, Manual, Permits, Disposal Records
QC Samples	SOPs	Corrective Action	Correspondence	Employee Handbook
Sample data		Logbooks*	QAPP	OSHA 29 CFR Part 1910
Software (Version control)		Method & Software Validation, Verification	SAP	Personnel files, Employee Signature & Initials, Training Records
		Standards Certificates	Telephone Logbooks	Technical and Administrative Policies

*Examples of Logbooks: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature,

4.12.2. Record Retention

Table 3 outlines STL'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. Drinking Water records are required to be stored for 10 years.

Table 3 STL Record Retention

Record Type	Department	Archival Requirement
Raw Data	All	5 Years from project completion
Controlled Documents	All	5 Years from document retirement date
QC	All	5 Years from archival
Project	All	5 Years from project completion
Administrative	Personnel/Training	7 years
	Accounting	See Accounting and Control Procedures Manual

4.12.3. Programs with Longer Retention Requirements

Specific client projects and regulatory programs have longer record retention requirements than the STL standard record retention length. In these cases, the longer retention requirement is 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 who to contact for authorization prior to destroying the data.

4.12.4. Archives and Record Transfer

Archives are 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.

STL ensures that all records are maintained as required by the regulatory guidelines and per the LQM upon facility location change or ownership transfer.

Stored information may consist of hardcopy or electronic data stored on a magnetic media.

All hardcopy information is stored at the laboratory that generated the data or off-site at a commercial document storage facility equipped with a professional security system.

All electronic data is stored on-site at the laboratory that generated the data or off-site at a commercial document storage facility equipped with a professional security system and a controlled environment suitable for storage of magnetic media.

Access to archived information is controlled by the appropriate data management custodian or facility manager.

At STL-Connecticut, reports for the current year are filed by the data management department. The report files along with any data package are then stored in numbered boxes. The number of the box is recorded into the cross reference logs and then stored in the designated storage area. The previous year's data is stored off-site at a secure storage facility. All jobs must be signed out in a logbook if being removed from the data management area.

STL ensures that all records are maintained as required by the regulatory guidelines and per the LQM upon facility location change or ownership transfer. Upon STL facility location change, all archives are retained by STL in accordance with the LQM. Upon ownership transfer, record retention requirements are addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established without disclosing client confidentiality. Clients shall be notified in the case of ownership transfer.

In the event that the laboratory is closed, all final test reports generated by the laboratory will be submitted to the clients if not previously provided. All records will then be transferred to STL's corporate record storage location. All boxes and contents will be appropriately labeled with the dates of destruction (Refer to Tables 5 and 6) and managed in accordance their policies.

4.13. Internal Audits

4.13.1. Audit Types and Frequency

A number of types of audits are performed at STL. Audit type and frequency are categorized in Table 4.

Table 4. Audit Types and Frequency

Audit Type	Performed by	Frequency
Systems	QA Department or Designee	Annual

Audit Type	Performed by	Frequency
Data	QA Department or Designee	**Data Report Review:** As necessary to ensure an effective secondary review process
		Analyst Data Audits: 100% of all analysts annually
		Electronic Data Audits: 100% of all organic instruments
Special	QA Department or Designee	As Needed

4.13.2. Systems Audits

Facility systems audits are technical in nature and are conducted on an ongoing basis by the QA Manager or his/her designee at each facility. Systems audits cover all departments of the facility, both operational and support.

The audit report is issued by the Internal Auditor of the facility within 30 calendar days of the audit. The audit report includes the following elements: Introduction, Scope of Audit, Type of Audit, Improvements and Innovations, Deficiencies, and a timeframe within which the audit must be addressed. The audit report is addressed to the Laboratory Director and copied to the General Manger. If the internal audit is performed by someone other than the facility QA Manager, the report must also be addressed to that QA Manger.

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.

4.13.3. Data Audits

Data audits are focused to 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. Data audits may be accomplished through electronic instrument data audits, analyst data authenticity audits or final project report review.

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 Section 5.3.6.

Records of the data audits are kept, and the frequency of data audits is 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 process evaluation and change.

Where specific clients and regulatory programs require more frequent data auditing, the individual facility meets the data auditing frequency for that program. For projects falling under the DOD QSM, a 10% data audit frequency shall be followed.

4.13.3.1 Data Authenticity Audits

Data authenticity audits shall be performed on 100% of all analysts by the QA department or a designee independent from the operations. Performing data authenticity checks will typically include verifying raw data, evaluating calculation tools and independently reproducing the final results and comparing it to the hardcopy on randomly selected batches of data. The QA manager will report the percentage of analysts reviewed (for the year) in the monthly QA report and should average about 8% per month.

4.13.3.2 Electronic Data Audits

Electronic data audits are performed on 100% of all organic instruments by the QA department or a designee independent from the operations. This may include Mint Miner® scanning of randomly selected batches of electronic data followed by a chromatography system review. The QA manager will report the percentage of instruments reviewed (for the year) in the monthly QA report and should average about 8% of instruments per month. Electronic data audits include spot-checking of manual integrations by QA personnel in order to determine that the manual integration is appropriate and documented.

4.13.3.3 Final Reports Reviews

The frequency of auditing final reports depends on the effectiveness of the laboratory's secondary review process. If the laboratory infrequently finds report errors or there is a low percentage of revised reports due to analytical error, audits may be less frequent.

4.13.4. 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 focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

4.13.5. External Audits

STL facilities are routinely audited by clients and external regulatory authorities. STL is available for these audits and makes every effort to provide the auditors with the personnel, documentation, and assistance required by the auditors. STL recommends that the audits be scheduled with the QA Department so that all necessary personnel are available on the day of the audit.

4.14. Management Reviews

4.14.1. QA Reports to Management

A monthly QA report is prepared by QA Manager and forwarded to the Laboratory Director, the GM, and the Corporate QA Manager. The reports include statistical results that are used to assess the effectiveness of the Quality System. The format of the monthly report is shown in Figure 1.

4.14.2. Management Systems Review

A Quality Management Systems review of the facility is performed at least annually by either the Laboratory Director, QAM or his/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 are accomplished through monthly quality assurance reporting, goal setting and an annual LQM review and revision.

4.14.3 Monthly QA Report and Metrics

By the 3rd day of the month, the QA manager prepares a monthly QA report. The report is sent to the Laboratory Director, General Manager and Corporate Quality Director. The report contains a narrative summary and metrics spreadsheet . At a minimum, the report content contains the items listed below (Figure 1). During the course of the year, the Laboratory Director, General Manager or Corporate Quality Director may request that additional information be added to the report.

Figure 1. Monthly QA Report Format

1	Audits
	Internal System Audits External System Audits
2	Revised Reports / Client Feedback
	Revised Reports Client Complaints Client Compliments
3	Certification Changes
	Changes Losses / Revocations
4	Proficiency Testing
	Study participation and scores Combined PT scores Repeat failures
5	SOP Status
	Report the percentage of SOPs that have been revised or reviewed within the last 24 months.
6	Miscellaneous QA and Operational Issues
	Narrative outlining improvements, regulatory compliance issues and general concerns.
Appended	Metrics Spreadsheet
	Summarize metrics in template provided by the Corporate Quality Director

5. *Technical Requirements*

5.1. Personnel

5.1.1. General

The STL-Connecticut management 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-Connecticut staff consists of over forty professionals and support personnel that include:

- Laboratory Director
- Senior Management
- Quality Assurance Manager
- Information Systems Analyst
- Analytical Chemists
- Laboratory Technicians
- Sample Custodian
- Health and Safety/Waste Management Coordinators
- Customer Service Staff
- Account Executives

In order to ensure that employees have sufficient education and experience to perform a particular task, job descriptions are defined for each laboratory position. Job descriptions are located on the STL Intranet HR web page.

The personnel who are responsible for operations of sample analyses and data validation are outlined in Section 5 of the Appendix. Section 1 of the appendix presents professional profiles of key personnel within the STL-Connecticut organization. Profiles of additional STL staff members are available for review during a facility visit or are available upon special request.

5.1.2. Training

STL is committed to furthering the professional and technical development of employees at all levels. The QA Manager and the Laboratory Management may periodically review the training needs of the staff and make recommendations for any additional training. Each department within the laboratory is responsible for personnel training. Each training session, whether it be individual or group training must be documented utilizing the forms attached to the SOP for Employee Training. The completed forms must be submitted to the Human Resource department for placement into the employee training files.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. The QA section, in conjunction with the Human Resources section are responsible for maintaining documentation of these activities.

Project specific training may also take place. Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project by the Project Manager. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. Group Leader will then hold departmental meeting to discuss upcoming projects. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality.

The following evidence items are maintained in the employees technical training file for each technical employee:

- Initial Demonstration of Capability (IDOC)
- 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.
- Annual evidence of continued DOC that may include successful analysis of a blind sample on the specific test method; a similar test method; an annual DOC; or four successive and acceptable LCSs.
- An ethic Agreement signed by each staff member (renewed each year)
- A confidentiality agreement signed by each staff member (renewed each year)
- Documentation of external training courses attended
- All training regarding QA policies and procedures

Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee's secured personnel file. This includes:

- An Ethics Agreement signed by each staff member (renewed each year).
- A Confidentiality Agreement signed by each staff member (renewed each year).

Minimum training requirements for STL-Connecticut employees are outlined in Table 5.

Table 5 STL Employee Minimum Training Requirements

Required Training	Time Frame [1]	Employee Type
Environmental Health & Safety	Month 1	All
Ethics	Two Weeks	All
Data Integrity	Two Weeks	Technical and PMs
Ethics Refresher	Annually	All
Quality Assurance	Quarter 1	All
Initial Demonstration of Capability (IDOC)	Prior to unsupervised method Performance	Technical

[1] From the date of initial employment unless otherwise indicated.

Technical training is accomplished within each laboratory by management to ensure method comprehension. All new personnel are required to demonstrate competency in performing a particular method by successfully completing an Demonstration of Capability (DoC) before conducting analysis independently on client samples.

DoCs are performed by analysis of four replicate QC check 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 (where available). If the test method does not include accuracy and precision requirements, the results are compared to 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. An DoC Certification Statement is recorded and maintained in the employee's training or personnel file. Figure 2 shows an example of a DoC Certification Statement.

Continuing DoCs certification is required annually and must be documented in the same manner as the DoC.

Figure 2 Demonstration of Capability Certification Statement

Demonstration of Capability
Certification Statement

Laboratory Name: Date:
Laboratory Address:

Method:_____
Matrix: _____

Analyst Name:

We the undersigned certify that:

1. The analyst identified above, using the cited test method, which is in use at this facility for the analysis of samples under the National Environmental Laboratory Accreditation Program, have met the Initial Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification.
3. Copies of the test method and SOP are available for all personnel on site.
4. The data associated with the DoC are true, complete and representative.
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is available for review by authorized inspectors.

Laboratory Manager/Supervisor	Signature	Date
Quality Assurance Manager	Signature	Date

5.1.3. 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 4). Each employee shall sign the Ethics Agreement, signifying agreed compliance with its stated purpose.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions 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 training program. Each employee must be trained in ethics within three months of hire in a training program that includes an overview of regulatory programs and program goals, a review of the ethics statement, and group discussions about data integrity and data misrepresentation. Employees must be trained as to the legal and environmental repercussions that result from data misrepresentation. A data integrity hotline is maintained by STL and administered by the QA Director. An annual refresher in ethics will be held for each employee.

Figure 3 STL Ethics Agreement

Severn Trent Laboratories, Inc.

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 non-authentic 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 _____

5.2. Facilities

The laboratory is a secured facility with controlled and documented access. Access is controlled by various measures including locked doors (key access), and a staffed reception area. All visitors sign in and are escorted by STL Connecticut personnel while at the facility. The laboratory is locked at all times, unless a receptionist is present to monitor building access (e.g., between the hours of 8:30 a.m. and 5:00 p.m. Monday through Friday).

The laboratory currently maintains a staff of approximately 40 environmental professionals and occupies a facility of approximately 14,000 sq. ft. Separate laboratory areas are dedicated to GC instrumentation, GC/MS instrumentation, extractions for organic parameters, sample preparation for metals analysis, metals analysis and wet chemistries. The floor plan of the analytical laboratory is included in Section 4 of the Appendix.

The volatiles analysis laboratory containing GC/MS instrumentation has a separate air handling system which is maintained at a positive pressure at all times. The organic sample preparation laboratory has a separate HVAC system that creates negative pressure in the area. This design results in a contaminant-free environment for trace-level volatiles analysis.

Critical instrumentation such as GC/MS units, ICP's, AA's, data systems, gas chromatographs and LIMS are tied into an uninterruptible power supply system (UPS) to minimize instrument downtime and damage for short duration power interruptions.

The sample receipt and storage area is under the responsibility of the sample custodian. A locked walk-in refrigeration unit and 10 locked commercial refrigerator units are used to house samples waiting for analysis. Samples for volatile analysis are stored in separate units. Locked laboratory refrigerators, located throughout the laboratory, are used to maintain sample extracts or laboratory reagents. Each laboratory refrigerator is dedicated to sample, sample extract, or reagent storage.

All STL facilities are equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. STL also provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, respirators, etc.

5.3. Test Methods

5.3.1. Method Selection

Most of the test methods performed at STL-Connecticut originate from test methods published by a regulatory agency such as the US EPA 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, US EPA, 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, June 1991.

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, ILM04.1, USEPA Contract Laboratory Program Multi-media, Multi-concentration.

Statement of Work for Organics Analysis, OLM03.2, USEPA Contract Laboratory Program, Multi-media, Multi-concentration.

Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, OLM04.2/OLM04.3, USEPA Contract Laboratory Program, September 1998.

Standard Methods for the Examination of Water and Wastewater, $18^{th}/19^{th}$ 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.

5.3.2. SOPs

Each STL facility maintains an SOP Index for all standard, non-standard, and laboratory developed methods. SOPs are also maintained for describing processes that are not related to a specific method. Method SOPs are maintained to describe a specific test method. Process SOPs are maintained to describe function and processes not related to a specific test method.

Method SOPs contain the following information:

Title Page with Document Name, Document Number, Revision Number, Effective Date, Page Numbers and Total # of Pages, Authorized Signatures, Dates and Proprietary Information Statement (Figure 4).

1. Identification of Test Method
2. Applicable Matrix
3. Reporting Limit
4. Scope and Application, including test analytes
5. Summary of the Test Method
6. Definitions
7. Interferences
8. Safety
9. Equipment and Supplies
10. Reagents and Standards
11. Sample Collection, Preservation, Shipment and Storage
12. Quality control
13. Calibration and Standardization
14. Procedure
15. Calculations
16. Method Performance
17. Pollution Prevention
18. Data Assessment and Acceptance Criteria for Quality Control Measures
19. Corrective Actions for Out-of-Control Data
20. Contingencies for Handling Out-of-Control or Unacceptable Data
21. Waste Management
22. References
23. Tables, Diagrams, Flowcharts and Validation Data

Process SOPs contain the following information:

Title Page with Document Name, Document Number, Revision Number, Effective Date, Page Numbers and Total # of Pages, Authorized Signatures, Dates and Proprietary Information Statement (Figure 4).

1. Scope
2. Summary
3. Definitions
4. Responsibilities
5. Safety
6. Procedure
7. References
8. Tables, Diagrams, and Flowcharts

Reference the STL-Connecticut SOP on SOPs for the exact format.

The QA Department is responsible for maintenance of SOPs, archival of SOP historical revisions, and maintenance of an SOP index. SOPs, at a minimum, undergo annual review. Where an SOP is based on a published method, the laboratory maintains a copy of the reference method.

Figure 4 Proprietary Information Statement

This documentation has been prepared by Severn Trent Laboratories (STL) solely for STL's own use and the use of STL's customers in evaluating its qualifications and capabilities in connection with a particular project. The user of this document agrees by its acceptance to return it to Severn Trent Laboratories upon request and not to reproduce, copy, lend, or otherwise disclose its contents, directly or indirectly, and not to use if for any other purpose other than that for which it was specifically provided. The user also agrees that where consultants or other outside parties are involved in the evaluation process, access to these documents shall not be given to said parties unless those parties also specifically agree to these conditions.

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SOP Appendix
In some cases, a standard laboratory procedure is modified slightly 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 which are specific to that project. SOP appendices shall not be used to alter test methods required by regulation such that the modifications would results in non-compliances.

5.3.3. Method Validation

Laboratory developed methods are validated and documented according to the procedure described in Section 5.3.5.

5.3.4. Method Verification

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 verification commonly will minimally require Determination of Method Sensitivity and Determination of Accuracy and Precision as described in Section 5.3.5. When implementing new, but previously validated methodologies, method verification may require additional activities such as Determination of Range.

5.3.5. 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 laboratory developed methods. While method validation can take various courses, the following activities are generally required as part of method validation. Method validation records are designated QC records and are archived accordingly.

Determination of Method Selectivity
Method selectivity is 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 is 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. The laboratory determines MDLs are described in Section 4.4.3.6 and the corporate procedure S-Q-003.

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 is done so with a qualification that denotes the semi-quantitative nature of the result.

Determination of Interferences
A determination that the method is free from interferences in a blank matrix is performed.

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.

Demonstration of Capability
DoCs are performed prior to method performance.

Determination of Accuracy and Precision
Accuracy and precision studies may be required as a separate determination from the IDC. 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 is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an 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.

5.3.6 Data Reduction and Review

Analytical data are entered/downloaded directly into LIMS or recorded on pre-formatted bench sheets that are paginated and bound into laboratory logbooks. These logbooks are issued and controlled by the laboratory's QA Section. A unique document control code is assigned to each book to assure that chronological record keeping is maintained.

Analytical data is referenced to a unique sample identification number for internal tracking and reporting. Both LIMS entries and logbook pages contain the following information, as applicable: analytical method, analyst, date, sequential page number, associated sample numbers, standard concentrations, and raw data. Entries are in chronological order and maintained so as to enable reconstruction of the analytical sequence.

The analyst is responsible for entering / recording all appropriate information, and for signing and dating all logbook entries daily. All entries and logbook pages are reviewed for completeness by a supervisor, peer reviewer. Data review checklists document the analytical review of the LIMS entries, logbook and associated QC indicators. Copies of instrument outputs (chromatograms, mass spectra, etc..) are maintained on file or electronically with the analyst's signature/initials and date.

5.6.3.1 Data review

All data, regardless of regulatory program or level of reporting, are subject to a thorough review process. All levels of the review are documented.

Initial Review

The initial 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 initial 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 initial 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 initial 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 to indicate manual integrations are recorded.
- Manual integrations are authorized by a date and signature or 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 documented and communicated.
- COC procedures have been followed.
- Initial review is documented by date and initials/signature of primary analyst.

Any anomalous results and/or non-conformances noted during the Initial Review are communicated to the Supervisor and the PM for resolution. Resolution can require sample reanalysis, or it may require that data be reported with a qualification. Non-conformances are documented per Section 4.9.

The laboratory employs a system of QA sign-off sheets called QC Batch Approval Forms and Quality Control Approval Reports (QCAR's), where each analyst must sign off that their respective part of the analysis is complete and meets the QA/QC requirements of the governing SOP. Both the Volatile and semi-volatile computer systems produce batch-specific QC summary reports to check various analytical parameters. Analysis QCAR's are filed with the analysis batches while the final deliverable QCAR's are signed and placed in each job folder along with any Corrective Action Forms (CAF) which details any problems which were encountered in the measurement of samples. Any deviations from SOPs are noted on CAF's and explained in the SDG narrative which is incorporated into the final report. The group leader has final sign-off responsibility on the QCAR and is responsible for assuring the overall quality of the data.

Secondary Review

The secondary review is a complete technical review of a data set and is performed by the Group/Section or designee. The secondary review is documented and the secondary reviewer is 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 – 100% as verified by signature of secondary data reviewer
- 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. It is at this time the case narrative is written for the report.

Completeness Review

The completeness review performed by the Project Manager, the includes the review 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 with all samples present?
- Does the data meet with the client's expectations?
- If available, were the data quality objectives of the project met?
- Are QC outages and/or non-conformances approved and appropriately explained in the narrative notes?

5.3.6.1 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the section manager or alternate analyst prior to updating the data in LIMS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the STL Corporate SOP entitled *Acceptable Manual Integration Practices* (S-Q-004).

Copies of all raw data and the calculations used to generate the final results, such as bound logbooks, are retained on file for a minimum of 5 years or as otherwise requested by the client/project.

Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

The following sections will describe the general procedures which are employed at the STL-Connecticut laboratory. More specific detail can be found in the standard operating procedures.

- Gas Chromatography

Data from the Gas Chromatographs is acquired through interfaces with a computer system utilizing Perkin Elmer Turbo Chrom chromatography software. After acquisition, the data is automatically copied to the Thermo analytical systems Target software package for data processing and quantitation. Data is reviewed at the bench level by the analyst. The data is reviewed for chromatographic scaling and dilutions. Necessary reintegrations and rescalings are done using Target. On column result data is then transferred to the labnet LIMS system. Prep data is manually entered and then linked to the analyses for final result calculation. If the data meets QC requirements, final reports are printed.

- GC/Mass Spectrometry

GC/MS data is acquired utilizing Hewlett Packard Chemstation computer systems with Environquant software. After acquisition, the data is automatically copied to the Thermo analytical systems Target software package for data processing and quantitation. This software allows for the comparison of sample non-target spectrum against reference library spectra. The most recent NIST/EPA mass spectral library supported by the system must be used. On column result data is then transferred to the labnet LIMS system. Prep data is manually enter and then linked to the analyses for final result calculation. Data is reviewed by the analyst. If the data meets QC requirements, final reports are printed.

- Atomic Spectroscopy

ICAP metals are analyzed by a Thermo-Jarrel Ash 61E or 61E Purge. The raw data collected is transferred via a network system to the labnet LIMS system. Mercury data is analyzed on the mercury analyzer and is transferred via a network system to the labnet LIMS system. Prep data is manually entered and then linked to the analysis for finally result calculation.

- Classical Chemistry

Routine wet chemistry analyses have pre-printed logbooks, such as distillation logs and digestion logs. The less frequent analyses are recorded in analysts' notebooks. Raw data is then entered into the LIMS for data calculation. This includes the calibration curve data which may have been previously entered. Semi-automated analyses performed on the Lachat produce results. These results are then electronically transferred to the LIMS system. Any associated prep data is manually entered and then linked to the analysis for final result calculation. Any raw data produced is stored in a central file.

5.3.7 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. STL Connecticut uses Labnet, STL's propriety LIMS, for Quotes, Project setup, sample login, standard and reagent traceability, data and report generation.

Security and Traceability

Access to computer systems that collect, analyze, and process raw instrumental data, and those that manage and report data is both controlled and recorded. There are various systems at STL 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 perform the task knowledgeably and accurately. 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. 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 as described in Section 5.4.1 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 is activated on any computer system that has that capability.

Outputs from all instruments are monitored for readability and consistency. If clarity is less than desired, corrective actions are undertaken to rectify the output based on instrument manufacturers' recommendations.

Verification

All commercially obtained software is 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 QC records.

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 QC records.

Auditing

The QA Department systems audit includes review of the control, security, and tracking of Information Technology (IT) systems and software.

STLs LIMS System Managers continually review the control, security, and tracking of IT systems and software.

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 5 years from its retirement date. The associated hardware, required to operate the software, is also retained for the same time period.

5.4. Equipment

5.4.1. Equipment Operation

STL facilities maintain state of the art instrumentation to perform the analyses within the QC specifications of the test methods. Each STL facility maintains an equipment list that includes the following information:

- 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. Table 6 lists STL's major equipment.

Table 6 Major Equipment List

Instrument Type	Number
Gas Chromatograph (GC)	6
Gas Chromatograph/Mass Spectrometer (GC/MS)	8
Air Desorber	1
Inductively Coupled Argon Plasma Emission Spectrophotometer (ICP)	2
Mercury Cold Vapor Analyzer	1
Infrared Spectrophotometer (IR)	1
Wet Chemistry Autoanalyzer	2
Ion Chromatograph	1
UV-Visible Spectrophotometer	2
TOC Analyzer	2

5.4.2. Equipment Maintenance

STL 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 recommended by the manufacturer and may be performed by an analyst, instrument specialist or outside technician. Maintenance logbooks are 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. Section 5 of the Appendix outlines the Preventive Maintenance performed at STL Connecticut.

Where it is desirable, the STL-Connecticut laboratory has service contracts for major instruments. These contracts provide routine preventive maintenance according to the manufacturer's requirements. Additionally the laboratory maintains an inventory of expendable parts and supplies to minimize downtime and to allow laboratory personnel to make minor repairs if necessary.

5.4.3. Equipment Verification and Calibration

All equipment is 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 is documented in instrument run and maintenance logbooks. Once an instrument is placed in routine service, ongoing instrument calibration is demonstrated at the appropriate frequency as defined in the test method. The calibration data, which includes instrument conditions and standard concentrations, is documented in pre-formatted instrument runlogs or within LIMS itself. The preparation of all reference materials used for calibration is documented via LIMS. Refer to Corporate SOP P-T-001, Selection of Calibration Points for Proper handling of Calibration data. 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.

5.5. Measurement Traceability

5.5.1. General

Traceability of measurements is assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration are not necessarily documented in a test method analysis or by analysis of a reference standard is subject to ongoing certifications of accuracy.

These include procedures for checking specifications ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. With the exception of Class A Glassware (including glass microliter syringes that have a certificate of accuracy), quarterly accuracy checks are performed for all mechanical volumetric devices. Eppendorf pipets shall be verified monthly and checked prior to use. Wherever possible, subsidiary or peripheral equipment is

checked against standard equipment or standards that are traceable to national or international standards.

The accuracy of any non standard lab ware, such as plastic digestion cups or sample vials, used to measure initial sample volumes or final sample extract volumes must be verified one per lot. Class A glassware such as flasks, pipets, graduated cylinders and volumetrics shall be verified one per lot prior to being put into service within the lab. Accuracy must be verified to within 3 percent in accordance with ASTM procedures.

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 thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

Laboratory SOPs specify the required level of accuracy in volumetric glassware. In all cases, volumetric glassware meets the requirements specified in the published test method.

5.5.2. Reference Standards

The receipt of all reference standards is documented in labnet. References standards are purchased from commercial vendors and labeled with a unique Standard Identification Number, date received, and the expiration date. The expiration dates for ampulated solutions shall not exceed the manufacturer's expiration date. Expiration dates for laboratory-prepared stock and diluted standards shall be no later than the expiration date of the stock solution or material first. Expiration dates for pure chemicals shall be established by the laboratory and be based on chemical stability, possibility of contamination, and environmental and storage conditions. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

The preparation of all daughter solutions, whether a single or multiple-component stock, intermediate, or working standard solution, is documented in a standard solution preparation logbook, in a designated section of the analytical logbook or in the LIMS systems reagent program. This documentation references the Standard ID of the respective parent solution(s) used in its preparation, providing a solid trail back to the solution or chemical received from the vendor. These records include the standard name, final volume, matrix, final concentration, analyst initials, prep date and expiration date. A daughter solution should not have an expiration date which post-dates any of the parent solutions used in its preparation.

Where possible standards are purchased with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The documentation of standard purity is archived, and references the Standard Identification Number.

All efforts are made to purchase standards that are $\geq$ 97.0% purity. If this is not possible, the purity is used in performing standards calculations.

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 QC criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an ICV or LCS is used as the second source confirmation.

Storage conditions, such as shelf life, ambient or chilled, controlled or restricted access, wet or desiccated, etc.., are in conformance with the specifications set in the associated method, the program requirements, or the manufacturer's recommendation, as appropriate.

Analytical Calibration Standards

The calibration standards used for instruments and equipment are described in the specific analytical methods, or instrument manufacturers' operational guides. All standard preparations are recorded in a bound "Standards Preparation Log Book" or entered into labnet, with the lot number, method of preparation, date and analyst's initials. The labnet system and or log provides the internal documentation which traces the internal working standards to primary and secondary (purchased) stocks.

Samples shall not be stored in the same areas as the standards.

Records on the traceability of the standards are maintained within each department. These records include sources, dates of receipt, lot numbers (if applicable) and expiration dates (if applicable). All purchased standards shall be traceable to NIST Standards including EPA/A2LA standards.

Table 7 provides an overview of the standard sources, types and preparation by instrument group.

- Metals Calibration Standards

Commercially available at 1000 ppm levels from Inorganic Ventures and prepared from primary standard material traceable to NIST Standards including EPA/A2LA standards. Stock standards solutions are prepared every six months or when needed as multi-element stocks.

- Inorganic Calibration Standards

Calibration standards described in the methodology use ACS Reagent Grade materials. Some reference materials are available from NIST to standardize titrating solutions. Stock solutions are prepared every three months while diluted working standards are prepared daily at the time of analysis

- Organic Calibration Standards

Pure compounds, Calibration mixes and Spike solutions for organic compounds are available through, Protocol, Supelco, Inc., Restek, Inc. and Accustandard, Inc. Volatile organic stocks are

prepared every six months and diluted working standards are prepared weekly. Stock non-volatile solutions can be prepared every six months and diluted working standards are prepared as needed.

- pH Calibration Standards

Calibration materials which are certified by the manufacturer to be standardized against NIST Standards are commercially available and are used by the laboratory. Three standards - 4,7, and 10 are used daily to calibrate the pH meters.

- Weighing Calibration Standards

Analytical balances are certified annually. Calibration is performed on a weekly or daily basis using class "S" weights (0.50, 5.00, and 50g). All Class S weights shall be calibrated within 5 years and traceable to NIST.

- Oven Calibration Standards

Daily calibration by monitoring oven temperature with a thermometer calibrated annually with a NIST Certified Thermometer. Digital thermometers shall be calibrated on a quarterly basis.

- Conductivity Calibration Standard

Conductivity solutions are described in Standard Methods, 18th edition, Section 502.

- Turbidity Standards

Formazin solution prepared from CMS neat standard according to EPA Method 180.1-2. Four standards are used to prepare a calibration curve and are made fresh daily. The stock formazin standard is prepared every three months and kept under refrigeration.

- Photometer Calibration Standard

Spectronic Standards - Catalog #331-31-50 (wavelength calibration).

TABLE 7 .STANDARD SOURCES AND PREPARATION

Inst. Group	Source	Form Received	Storage	Preparation from Source	Laboratory Storage	Preparation Frequency
GC/MS-Volatiles	Restek, Inc. EPA Supelco Accustandard Protocol	Neat Solutions> 1000 ppm	Frozen	Primary stocks are prepared from source stocks	Freezer	Semi-annual
				Intermediate stocks are prepared from primary or source stocks	Refrigerator	Weekly
				Working stocks are prepared from intermediates	N/A	Weekly
GC/MS GC - SV	Restek, Inc. EPA RTP Supelco Accustandard	Neat Solutions >1000 ppm	Frozen	Primary stocks are prepared from source stocks	Freezer	Semi-annual
				Intermediate stocks are prepared from primary or source stocks	Refrigerator	Semi-annually
				Working stocks are prepared from intermediates	Refrigerator Certain Pesticies stored at room temperature	Semi-annually
ICP	Inorganic Ventures	Solutions of 1000ppm	Room temp.	Primary stocks (1 - 10 ppm) are prepared from source	O.15% HNO_3 at room temperature	Annually
				Intermediate stocks (1ppb - 1 ppm)	0.15% HNO_3 at room temperature	Semi-annually or as needed
				Working stocks	0.15% HNO_3 at room temperature	Daily

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.

5.5.3. 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.

With the exception of the cycletainers, all solvents are pretested at an alternate STL facility. Documentation of approval is submitted to QA and posted on the STL intranet. All reagents are entered into the labnet lims system for tracking. The date of reagent receipt or preparation, and the date the reagent was opened are documented on the preprinted labnet label.

Cycletainers

STL-CT utilizes cycletainers for the organic Extractions solvents such as Hexane and Methylene Chloride. To access certification of these containers the distributor will fax a certificate of analysis from the manufacturer for the lots to be used to the QA Manager. These are kept on file. Cycletainers that do not come with a Certificate of Analysis must be pre-tested at the lab prior to being put into use. A sample of the solvent shall be concentrated and analyzed by the appropriate method. Solvents are tested and accepted in accordance with STLs Corporate *Testing Solvents and Acids* procedure (S-T-001). Documentation of lot verification must be in the extraction log and data kept on file with QA.

5.6. Sampling

Sample representativeness and integrity are the foundations upon which meaningful analytical results rely. Where documented and approved SAPs and/or LQMPs are in place, they must be made available to the laboratory before sample receipt, and approved by laboratory management before sample receipt.

5.7. Sample Handling, Transport, and Storage

5.7.1. General

Chain of Custody (COC) can be established either when bottles are sent to the field, or at the time of sampling. STL 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 thru the labnet system. 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 as described in Section 4.7.1 is documented on the labnet checklist 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. The sample data is then logged into the LIMS system by the Sample Management department.

Samples that are being tested at another STL facility or by an external subcontractor are repackaged, iced, and sent out under COC.

Following sample labeling as described in Section 5.7.1, the sample is placed in storage. Sample storage is required to 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 tolerance range of $\pm$ 2°C is used. The walk-in storage unit is monitored daily, all others are monitored each business day.

The National Enforcement Investigations Center (NEIC) of EPA defines custody of evidence in the following ways:

- It is in your actual possession; or
- It is in your view, after being in your physical possession; or
- It was in your possession and then you locked or sealed it up to prevent tampering; or it is in a secure area

At STL-Connecticut, chain of custody begins with shipment of the sample bottles and coolers. STL-Connecticut has a printed external chain-of-custody form that accompanies each sample shipment. An example of this form is found in Section 3 of the appendix.

Upon receipt of the samples in the laboratory the sample custodian and the sample control group are responsible for obtaining all necessary shipping documentation and verification of all data entered into the laboratory sample custody records. The internal laboratory custody form is generated at this point.

All samples and projects entering the laboratory are identified with a job/project number. Individual sample bottles are then identified using the job number and sample counter. The samples are then stored according to the requirements of the analytical protocols (refrigeration) and preservative type.

Preliminary sample receipt notifications are distributed to each department to notify department of sample arrival and facilitate the analysis of parameters with short holding times. Each department has a system of tracking sample analysis throughout their respective departments to ensure protocol holding times are met.

All documentation received with samples is reviewed by the sample custodian at the time of receipt. The project manager then reviews the paperwork and checks off the login review in labnet. If there are any discrepancies noted by the sample custodian, the client is then contacted for resolution.

The specific procedures and requirements for receiving samples are specified in the SOP for sample control - "Sample Processing Methods Performed at Sample Arrival". STL's chain-of-custody record is designed to meet the legal requirements of federal, state and local government agencies and the courts of law. The record covers:

- Labeling of sample bottles, packing the shipping container and transferring the shipping container under seal to the custody of a shipper;
- Outgoing shipping manifests;
- The chain-of-custody form completed by the person(s) breaking the shipping container seal, taking the sample, resealing the shipping container and transferring custody to a shipper;
- Incoming shipping manifests;
- Breaking the shipping container's reseal;
- Storing each labeled sample bottle in a secured area;
- Disposition of each sample to an analyst or technician; and
- The use of the sample in each bottle in a testing procedure appropriate to the intended purpose of the sample.

For each link in this process the records indicate the following:

- The person with custody; and
- The time and date each person accepted or relinquished custody.

STL has implemented the following standard operating procedures with regard to laboratory chain-of-custody:

- Samples are stored in a secure area;
- Non-employee access to the laboratories are controlled through the use of limited access points at each facility. Outside personnel can access the facility either through the front receptionist or the sample receipt area. Other access doors to the laboratory are maintained in a secure manner at all times;

- All visitors to each facility are required to sign-in at the reception area and must be escorted by an STL representative at all times while in the laboratory;

- The designated sample custodian and authorized personnel control access to the sample storage units; and

- Samples remain in secured sample storage until removed for sample preparation or analysis; and

All samples are stored in either the walk-in refrigerator or in a separate locked refrigerator. Samples must be stored at 4 ± 2° C. All unused portions of samples, including empty sample containers, are returned to the secure sample control area.

5.7.2. Sample Identification and Traceability

Each sample container is 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 a sample identification label. Access to samples is controlled and documented, identifying the identity of the sample handler, and date and time of sample access. All unused portions of th sample are returned to the Sample control area.

5.7.3 Subsampling

Taking a representative sub-sample from a container containing a soil or solid matrix is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation.

After thoroughly mixing the sample within the sample container or transfer to a wip bag (or other suitable plastic bag), a sub-sample from various quadrants and depths of the sample are taken to acquire the required sample weight. Any non-homogenous looking material is avoided and noted as such within the sample preparation record.

The procedure used for subsampling with the laboratory is outlined in the SOP for Compositing, Homogenization and splitting Environmental Samples.

5.7.4 Sample Preparation

Sample preparation procedures are documented in the laboratory's analytical SOPs.

5.7.5 Sample Disposal

Samples are retained in the STL-Connecticut storage facilities for 30 days after the project report is sent unless prior arrangements have been made with the client. Samples may be held longer or 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. All radioactive or dioxin containing samples will be returned to the client.

The STL-Connecticut laboratory has a designated hazardous waste storage area with bermed floors and separate ventilation. This area and satellite accumulation areas are the direct responsibility of the Hazardous Waste Manager (HWM). The HWM routinely inspections each area to ensure regulatory adherence.

Samples designated for disposal are removed from sample control and brought to the hazardous waste storage area. Samples designated for disposal may be returned to clients for disposal, on a case-by-case basis.

The laboratory sample waste to be disposed of is segregated by waste streams. Waste profiles have been generated for the following streams: acid liquid waste, NaOH liquid waste, vials (GC, GC/MS), waste organic solvent and waste pyridine. Other laboratory waste is disposed of through the established compatible waste streams. If no compatible waste stream is available the waste is sent out via lab pack procedure.

A Hazard Waste Minimization Plan has been prepared for the STL-Connecticut facility and is designed to minimize the volume and toxicity of all waste streams being generated whenever possible. This Hazard Waste Minimization Plan is designed to meet or exceed the requirements set forth in 54 FR 25056, June 12, 1989.

Each process that generates waste will be assessed to determine if there are ways to either reduce the volume or toxicity of waste being generated. It is unlikely that most processes will be changed due to the stringent EPA standard operating procedures which must be followed. Strong emphasis will, however, be placed on efficient use of products used to prevent excessive amounts from becoming waste.

5.8. Assuring the Quality of Test Results

5.8.1. Proficiency Testing

STL analyzes Proficiency Test (PT) samples as required for certification and as outlined in the National Environmental Laboratory Accreditation Conference (NELAC). Each STL facility participates in the PT program semi-annually for each area of testing and matrix (e.g. organics, inorganics, microscopy, radiological, microbiological; aqueous and drinking water) for which it is accredited. In addition to the PT program required for NELAC accreditation, STL participates in a number of additional PT programs, as appropriate for the specific facility, such as the Army Corps of Engineers Laboratory Assessment program.

PT samples are 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.

Double Blind Performance Evaluation

STL CT also participates in a double blind performance. An external vendor is contracted by the corporate QA Director 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 QA Director and to each of the STL facilities. This is administered as a double blind program in order to assess all facets of STL operations.

5.8.2. 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 Note that frequency and criteria of control samples vary with specific regulatory, methodology and project specific criteria.

5.8.2.1 Method Performance Control Samples: Preparation Batch

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment.

Control samples are added to each prep batch to monitor method performance (Table 8) and are processed through the entire analytical procedure with investigative/field samples.

Table 8. Preparation Batch Control Samples

Control Sample Type	Details	
Method Blank (MB)	Use	Monitors for potential contamination introduced during the sample preparation and analytical processes.
	Typical Frequency [1]	1 per batch of $\leq$ 20 samples per matrix type per sample extraction or preparation method.

Table 8. Preparation Batch Control Samples

Control Sample Type	Details	
	Description	Organics: Laboratory pure water for water samples or a purified solid matrix for soil or solid samples (when available or when requested); solid matrices commonly include sodium sulfate, vendor or agency supplied soil or solid, or purchased sand; these solids may require purification at the laboratory prior to use. Inorganics: Laboratory pure water for both water and soil or sediment samples. ***Volume/weights are selected to approximately equal the typical sample volume/weight used in sample preparation; and final results in a soil/solid batch may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison to actual field samples.***
Laboratory Control Sample (LCS)	Use	Measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects.
	Typical Frequency [1]	1 per batch of $\leq$ 20 samples per matrix type per sample extraction or preparation method. For multi-analyte methods, the LCS may consist of surrogates in the blank matrix, and or a representative selection of target analytes/internal standards.
	Description	Prepared from a reference source of known concentration and processed through the preparation and analysis steps concurrently with the field samples. Aqueous LCS's may be processed for solid matrices unless a solid LCS is requested; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the actual field samples.
Known QC Sample	Use	Comply with regulatory requirements; check the accuracy of an analytical procedure; troubleshoot method performance problems; verify an analyst in training's ability to accurately perform a method; to verify the return-to-control after method performance problems; and may also be used as an LCS.
	Typical Frequency [1]	As defined by the client or QAPP.
	Description	Obtained from outside suppliers or agencies; generally require preparation from concentrated materials by dilution into a standard matrix; contain known analytes or compounds; acceptance limits are provided by the vendor.

[1] Denotes an STL required frequency.

Field blanks, equipment blank and trip blanks, when received, are analyzed in the same manner as other field samples. However, a field blank should not be selected for matrix QC,

as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB".

5.8.2.2 Method Performance Control Samples: Matrix

Matrix control samples include sample duplicates (MD), sample matrix spikes (MS), and sample surrogate spikes. These control samples help monitor for potential physical and chemical effects which may interfere with the precision and/or accuracy of the selected analytical method. Since interferences can enhance or mask the presence of target analytes, matrix control samples measure the degree of interference and are used to assist in the interpretation of the analytical results. The laboratory avoids performing matrix QC on known field blank samples, such as trip blanks and rinsates, since these samples are not indicative of the sample matrix.

Table 9. Matrix Control Samples

Control Sample Type	Details	
Matrix Duplicate (MD)	Use	Monitors the effect of site matrix on the precision of the method; and of the reproducibility of laboratory preparation and measurement techniques. **Note:** Precision may also be affected by the degree of homogeneity of the sample, particularly in the case of non-aqueous samples or aqueous samples with particulates. Sample homogeneity and matrix effect should be considered when field samples are used to assess reproducibility. **Note:** A field duplicate, when received, measures Representativeness of sampling and the effect of the site matrix upon precision.
	Typical Frequency [1]	1 per 20 samples per matrix or per SAP/QAPP [2].
	Description	***Performed by analyzing two aliquots of the same field sample independently; analyzed for each associated sample matrix (e.g., when requested by the client or the analytical method).***
Matrix Spike (MS)	Use	Measures the effect of site sample matrix on the accuracy of the method.
	Typical Frequency [1]	1 per 20 samples per matrix or per SAP/QAPP.

Table 9. Matrix Control Samples

Control Sample Type	Details	
	Description	Aliquot of a field sample which is spiked with the analytes or compounds of interest; analyzed for each associated sample matrix (when requested by the client or analytical method). The determination of MS percent recovery (% R) requires an analysis of a fortified sample and a non-fortified sample under the same procedural conditions (e.g., sample volumes, dilutions, procedural conditions, etc..). The concentration determined in the non-fortified sample is subtracted from the fortified sample concentration before determining the %R. The degree of homogeneity of the sample, particularly in the case on non-aqueous samples or samples with particulates, may affect the ability to obtain representative recoveries.
Matrix Spike Duplicate (MSD)	Use	Measures effect of site sample matrix on precision of method.
	Typical Frequency [1]	1 per 20 samples per matrix, when requested by the client or the analytical method, or per SAP/QAPP [2].
	Description	Alternative to sample duplicate. Generally, inorganic protocols specify an MD/MS and organic protocols specify an MS/MSD.
Surrogate Spike	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Every QC and analytical sample.
	Description	Compounds similar to the target analytes in structure, composition and chromatography, but not typically found in the environment, are added to each QC and analytical sample, prior to preparation (e.g., extraction). If the surrogates in an analytical batch do not all conform to established control limits, the pattern of conformance in investigative and control samples is examined to determine the presence of matrix interference or the need for corrective action.
Internal Standards	Use	Monitor the qualitative aspect of organic and inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP/MS methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] Denotes an STL required frequency.
[2] Either an MSD or an MD is required per 20 samples per matrix or per SAP/QAPP.

5.8.3 Statistical Control Limits and Charts

Statistical control limits and control charts are used to establish method performance of a given analysis and to monitor trends of QC results graphically over time. Once a data base

of the laboratory results for a method/matrix/QC analyte combination is established, the acceptability of a given analysis of that QC parameter (and of the analytical batch to which it belongs) can be evaluated in light of the laboratory's normal performance. This is intended to help identify problems before they might affect data. Often, patterns of response that are not at all evident in sets of numbers are very distinct when the same values are viewed as a chronological graph.

Establishment of Limits

The purpose of using statistical control limits is to define, for each analyte in a given method/matrix/QC type combination, a range of expected values. This range encompasses the random variation that occurs normally in the laboratory and allows one to evaluate control samples in that context, rather than according to an arbitrary or external set of values. Limits for accuracy and precision are defined below:

Accuracy

As recoveries of a QC analyte in a given matrix are tabulated over time, a mean value for recovery is established, as is the standard deviation (s) of those recoveries. If the analysis is in statistical control (e.g., if the set of QC recoveries over time show random variation about the mean) approximately 99.7% of all recoveries for that QC will fall within three standard deviations (3s) of the mean. Thus, assuming that the mean itself is an acceptable level of recovery, the values corresponding to 3s above and 3s below the mean are defined as the Control Limits. Any single recovery outside these values is assumed to have resulted from some circumstance other than normal variation and shall be investigated.

Roughly 95% of points should fall within 2s of the mean. The values +2s and -2s are the Warning Limits. Any normal result has approximately a 1/20 chance of being between 2s and 3s from the mean, so a result in this region doesn't necessarily warrant corrective action, but attention should be paid to such points.

Precision

Precision is used to indicate matrix variability so that appropriate decisions can be made by the client when repeated analyses vary significantly. The coefficient of variation, expressed as a percentage (e.g., the %RSD) for the data set used to calculate accuracy control limits defines the control limit for precision. Duplicate analyses of the QC samples, such as duplicates or MS/MSD, should have an RPD less than or equal to this established precision control limit to be considered free of matrix interferences.

The laboratory calculates statistical control limits on an annual basis, or more frequently if change have been made to the analytical process which affects the chemistry of the method. Such limits are available on a project or QAPP-specific basis.

In the case where laboratory generated limits do not meet the requirements of a specific project or regulation then the project and regulatory limits shall supersede the laboratory defined limits.

5.8.4 Calibration

Calibration protocols are method specific and defined in STL facility method SOPs.

- Instrument Calibration Procedures

The proper calibration of instrumentation and equipment is a key element in the quality of the analysis done by the laboratory. Each type of instrumentation and each EPA approved method has specific requirements for the calibration procedures, depending on the analytes of interest and the medium of the sample.

Table 10 lists in tabular form the general procedures which are followed by STL Connecticut. The calibration protocols meet or exceed the minimum method criteria requirements. Exact details regarding calibration for each method are outlined in the analytical SOPs. If a method calibration requirement, outlined in a project specific QA Plan, is more stringent than those listed in the Quality Assurance Plan, the more stringent will be followed in each case.

Documentation and records on calibrations are maintained in instrument logs and also with the data sets of the samples which are analyzed and related to them. In addition, laboratory department managers monitor the results of the calibration program to ensure the proper implementation at the analyst level.

TABLE 10 INSTRUMENT CALIBRATION SUMMARY

Analysis	Cal. Type	# Standards	Type of curve	Acceptance/rejection criteria	Frequency
GC Pesticides Herbicides OP pesticides GRO/DRO	Initial Continuing	5 concentration levels 1 standard (mid)	Linear	$\leq$ 20% RSD $r^2 \leq 0.99$ +/- 15% Difference	continuing calibration fails every 12 hrs or 20 samples
GC/MS quadrupole	Initial Continuing	5 concentration levels; tuning with BFB/DFTPP 1 standard; tuning with BFB/DFTPP	Linear; tuned to manufacturer's specifications	$\leq$ 30% RSD $r^2 \leq 0.99$ +/- 20% Diff	continuing calibration failure Every 12 hours
ICP	Initially Daily Continuing	5 concentration levels 2 levels 1 standard	Linear	According to instrument manufacture's instructions	Quarterly Every 10 samples
Lachat Analysis	Initially, Daily Continuing	5 concentration levels 1 standard	Linear	<.995 coefficient of variation $r^2 \leq 0.99$	continuing calibration failure Every 10 samples
pH Meters	Initially and daily Continuing	3 standards 1 standard	Linear	+/- 95% of value $r^2 \leq 0.99$	Daily Every 10 samples
Spectrophoto-meter	Initially and daily Continuing	5 concentration levels plus set %T with no cuvette in holder 1 standard	Linear	<.995 coefficient of variation $r^2 \leq 0.99$ +/- 95% of value	Daily Every 10 samples
Infrared Spectrophoto-meter	Initially and monthly Continuing	5 concentration levels 1 level	Linear	<.995 coefficient of variation $r^2 \leq 0.99$ +/- 95% of value	Daily Every 10 samples
Conductivity meter	Daily Continuing	3 concentration levels 3 concentration levels	Linear	<.995 coefficient of variation $r^2 \leq 0.99$ +/- 95% of value	Daily Every 10 samples

TABLE 10 INSTRUMENT CALIBRATION SUMMARY

Turbidimeter	Daily Continuing	3 concentration levels 3 concentration levels	Linear	<.995 coefficient of variation $r^2 \leq 0.99$ +/- 95% of value	Daily Every 10 samples
Balance	Daily	3 levels Class "S" weights	Point		Check single weight upon use

5.8.5 Glassware cleaning

STL Connecticut employs rigorous cleaning procedures for all glassware used within the laboratory. Glassware washing procedures are to be posted at all relevant stations. Detailed procedures are outlined in SOP for Glassware Washing.

5.8.6 Procedure for Permitting Departures from Documented Procedure

Where a departure from a documented SOP, test method, or policy is determined to be or perceived to be necessary, or is unavoidable, the departure is documented on a non-conformance summary or in a format specifically designed for that purpose. The departure from procedure must be authorized by the QA Manager, the Laboratory Director or the department Manager. Where a departure affects a specific client project, the PM must be informed of the deviation. In some instances, it is appropriate to inform the client before permitting a departure. Any such occurrence is documented in the cover letter and/or project narrative.

5.8.7 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 examine 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 STL'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 (e.g., 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 ±25%, and RSD of <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.

5.9. Project Reports

5.9.1. General

Laboratory customers have a wide variety of analytical needs. In order to meet these varied requirements, the laboratory offer several levels of data reporting options ranging from very simple format to an extreme level of documentation. Table 11 presents the contents of various levels of reports offered by the laboratory. Custom reporting beyond those listed is usually available but may require additional cost. The information provided in Table 11 is a summary only. In some cases, individual methods may not include the indicated items. For example, in metals graphite furnace analysis an ICP interference check would not be included since it is inappropriate for that method.

The criteria described in Section 5.9.2 apply to all Project Reports that are generated under NELAC requirements. The criteria described in Section 5.9.3 and 5.9.4 apply to all Project Reports.

5.9.2. Project Report Content

- Title
- Laboratory name, address, telephone number, contact person
- Unique Laboratory Project Number
- Total Number of Pages (report must be paginated)

- Name and address of Client
- Client Project Name (if applicable)
- Laboratory Sample Identification
- Client Sample Identification
- Matrix and/or Description of Sample
- Dates: Sample Receipt, Collection, Preparation and/or Analysis Date
- Definition of Data Qualifiers
- Reporting Units
- Test Method

The following 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.

5.9.3. Project Narrative

A Project Narrative and/or Cover Letter is 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

Project Release

The Project Manager or his/her designee authorizes the release of the project report with a signature. The Laboratory Director or his/her designee authorizes the release of the project report narrative with a signature as required by the data reporting deliverables.

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.

5.9.4. 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. Data from subcontractors' reports may be added to an STL 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 5.9.2 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 is retained by the originating laboratory.
- All information as outlined in Section 5.9.2 is included in the final report where the report is required to be compliant with NELAC, for both the originating and subcontracting laboratory.

5.9.5. Electronic Data Deliverables

Electronic Data Deliverables (EDD) are routinely offered as part of STL's services. STL 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 are subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory demonstrates that it can routinely generate that EDD without errors. Any revisions to the EDD format are reviewed until it is demonstrated that it can routinely be generated without errors.

5.9.6. Project Report Format

STL offers a wide range of project reporting formats, including EDDs, short report formats, and complete data deliverable packages modeled on the Contract Laboratory Protocol (CLP) guidelines. Regardless of the level of reporting, all projects undergo the same levels of review as described in Section 5.3.6.

Table 11 Report Content Options

	Data reporting Options			
Wet Chemistry	Level 1	Level 2	Level 3 *	Level 4 (CLP)
Case narrative	Yes	Yes	Yes	Yes
Sample Results	Result forms	Result forms	Result forms	Result forms
Method Blank	Yes	Yes	Yes	Yes
External Chain of Custody	Yes	Yes	Yes	Yes
Internal Chain of Custody	Yes	Yes	Yes	Yes
Duplicate	-	Yes	Yes	Yes
Matrix Spike	-	Yes	Yes	Yes
Initial Calibration Verification (ICV)	-	-	Yes	Yes
Continuing Calibration Verification (CCV)	-	-	Yes	Yes
Laboratory Control Sample (LCS)	-	-	Yes	Yes
EPA Forms 1-14	-	-	Yes	Yes
Metals	Level 1	Level 2	Level 3 *	Level 4 (CLP)
Case Narrative	Yes	Yes	Yes	Yes
Sample Results	Result forms	Result forms	Result forms	Result forms
Method Blank	Yes	Yes	Yes	Yes
External Chain of Custody	Yes	Yes	Yes	Yes
Internal Chain of Custody	Yes	Yes	Yes	Yes
Duplicate	-	Yes	Yes	Yes
Matrix Spike	-	Yes	Yes	Yes
Initial Calibration Verification (ICV)	-	-	Yes	Yes
Continuing Calibration Verification (CCV)	-	-	Yes	Yes
Laboratory Control Sample (LCS)	-	-	Yes	Yes
ICP Interference Check	-	-	Yes	Yes
ICP Linear Range	-	-	Yes	Yes
ICP Post Spike	-	-	Yes	Yes
EPA Forms 1-14	-	-	Yes	Yes
Organics	Level 1	Level 2	Level 3*	Level 4 (CLP)
Case Narrative	Yes	Yes	Yes	Yes
Sample Results	Result forms	Result forms	Result forms	Result forms
Method Blank	Yes	Yes	Yes	Yes
External Chain of Custody	Yes	Yes	Yes	Yes
Internal Chain of Custody	Yes	Yes	Yes	Yes
Matrix Spike	-	Yes	Yes	Yes
Matrix Spike Duplicate	-	Yes	Yes	Yes
Laboratory Control Sample (LCS)	-	-	Yes	Yes
Surrogate Recovery Information	-	Yes	Yes	Yes
Tuning Data (GC/MS only)	-	-	Yes	Yes
Initial Calibration Information	-	-	Yes	Yes
Continuing Calibration Information	-	-	Yes	Yes
Run Sequence Logs	-	-	Client Specific	Client Specific
Sample Preparation Logs	-	-	Yes	Yes
Chromatograms and Mass Spectra	-	-	-	Yes
EPA Forms 1-8	-	-	Yes	Yes

* Raw backup data not provided

Table 12 Correlation of QMP Sections with NELAC Quality Manual Requirements

NELAC Chapter 5.5.2 Quality Manual	Quality Management Plan Section
a. Quality policy statement, including objectives and commitments	1.2 Quality Assurance Policy 4.2.1 Objectives of the Quality System
b. Organization and management structure	4.1 Organization and Management
c. Relationship between management, technical operations, support services and the quality systems	4.1.2 Roles and Responsibilities 4.2 Quality System
d. Records retention procedures; document control procedures	4.3 Document Control 4.12.2 Record Retention
e. Job descriptions of key staff and references to job descriptions of other staff	4.1.2 Roles and Responsibilities
f. Identification of laboratory approved signatories	4.1 Organization and Management
g. Procedures for achieving traceability of measurements	5.5 Measurement Traceability
h. List of all test methods under which the laboratory performs its accredited testing	5.3.1 Method Selection
i. Mechanisms for assuring the laboratory reviews all new work to ensure that it has the appropriate facilities and resources before commencing such work	4.4.2 Project-Specific Quality Planning
j. Reference to the calibration and/or verification test procedures used	5.4.3 Equipment Verification and Calibration
k. Procedures for handling submitted samples	4.7.1 Sample Acceptance Policy 5.7 Sample Handling, Transport and Storage
l. Reference to the major equipment and reference measurement standards used as well as the facilities and services used in conducting tests	5.2 Laboratory Facilities 5.4.2 Equipment Maintenance 5.4.3 Equipment Verification and Calibration
m. Reference to procedures for calibration, verification and maintenance of equipment	5.4.2 Equipment Maintenance 5.4.3 Equipment Verification and Calibration
n. Reference to verification practices including interlaboratory comparisons, proficiency testing programs, use of reference materials and internal QC schemes	5.8.1 Proficiency Testing 5.8.2 Control Samples
o. Procedures for feedback and corrective action whenever testing discrepancies are detected, or departures from documented procedures occur	4.9 Control of Non-Conformances 4.10 Corrective Action 4.11 Preventive Action 5.8.6 Permitting Departures from Documented Procedures

Table 12 Correlation of QMP Sections with NELAC Quality Manual Requirements

NELAC Chapter 5.5.2 Quality Manual	Quality Management Plan Section
p. Laboratory management arrangements for exceptionally permitting departures from documented policies and procedures	4.4.2 Project-Specific Quality Planning 5.8.6 Permitting Departures from Documented Procedures
q. Procedures for dealing with complaints	4.8 Complaints
r. Procedures for protecting confidentiality and proprietary rights	4.7.2 Client Confidentiality and Proprietary Rights
s. Procedures for audits and data review	4.13 Internal Audits 5.3.6 Data Reduction and Review
t. Process/procedures for establishing that personnel are adequately experienced in duties they are expected to carry out and are receiving any needed training	5.1.2 Training
u. Ethics policy statement developed by the laboratory and training personnel in their ethical & legal responsibilities	5.1.3 Ethics Policy
v. Reference to procedures for reporting analytical results	5.3.6 Data Reduction & Review 5.9 Project Reports
w. Table of contents, listing reference, glossaries and appendices	TOC Table of Contents Appendix I: List of Cited SOPs and Misc. Laboratory Information

APPENDIX, Section 1

PROFESSIONAL PROFILES
OF
KEY PERSONNEL

The following professional profiles are presented alphabetically and represent the key quality assurance and laboratory management personnel for the network organization. Additional professional profiles are available for review during a site visit to any of our laboratory facilities.

Qualifications Summary

Mr. Frick has 20 years of experience in environmental and analytical chemistry that includes broad management and leadership experience. He is responsible for the overall direction of the laboratory and has extensive knowledge in environmental analytical chemistry and business management.

Professional Experience

Laboratory Director – 2004 to present

STL Connecticut—Shelton, CT
Mr. Frick directs the growth and development of the laboratory, including strategic plan development and implementation. He is responsible for all phases of operation within the Shelton, Connecticut facility, including; the technical and administrative management of the laboratory. The functional groups of the facility include Sample Control, Sample Preparation, Organic Chemistry, Metals, Wet Chemistry, Project Management, QA/QC and Information Technology, Report Generation, Data Management, and Human Resources. His other responsibilities include adherence to budget, staff development and control, quality assurance and quality control, scheduling, client support/liaison, as well as profit and loss responsibility for the facility. In addition, he is responsible for oversight of the Environmental Health and Safety Program, and was instrumental in the set up of the mixed waste license for the Connecticut laboratory.

Chromatography Product Manager
Supelco Incorporated—Bellefonte, PA—1998 to 2004

Laboratory Director
American Environmental Network—Schaumburg, IL—1996 to 1998

Laboratory Manager
Industrial Environmental Analysts—Schaumburg, IL—1995 to 1996

Group Leader
Industrial Environmental Analysts—Monroe, CT—1988 to 1995

Chemist
Environmental Analysis Corporation—Norwalk, CT—1984 to 1988

Education

- BS in Chemistry – University of Connecticut—Storrs, CT—1984
- MBA in Finance – University of Bridgeport—Bridgeport, CT—1993

Professional Training

- Environmental Laboratory Management —John H. Taylor, ACS Course
- Performance Management Workshop—Cynthia. Barnet, HR Consultant
- Interview Skills Workshop—Cynthia. Barnet, HR Consultant
- Frontline Leadership Development —William Frackler, Ingoldsby, Inc.
- 40 Hour OSHA Training —Lynn Sherman, YWC Midwest
- Radiation Safety Program Training —Radiation Safety Associates, Inc.
- Theory of Constraint Training—Sigma-Aldrich, Inc.
- Strategic Sales Management —Sigma-Aldrich, Inc.
- Corporate Finance Workshops—Sigma-Aldrich, Inc.

Professional Affiliations

- American Chemical Society

Qualifications Summary

Mr. Hobart has 14 years of experience in the environmental laboratory industry that includes management of the client services and sample control departments, project management responsibilities, and experience performing analyses. He possesses excellent presentation skills, communication skills, and writing proficiency. Paul is adept at motivating his team to achieve goals and objectives.

Professional Experience

Client Services Manager – 1999 to present

STL Connecticut -- Shelton, CT
Mr. Hobart's responsibilities include the administrative management of the project management, sample control and courier staff of the facility. He coordinates the project management staff with laboratory operations to ensure that projects are executed properly and effectively. He is responsible for generating and tracking price quotations, and for providing detailed forecasting and project schedules to the laboratory director. Additionally, Paul is responsible for the management of key client accounts.

Project Manager – 1996 - 1999
STL Connecticut – Whippany NJ and Shelton, CT

Project Manager – 1993 -1996
Quanterra, Inc. – Edison, NJ and Pittsburgh, PA

Analyst/Project Manager – 1990 - 1993
Analytica, Inc. – Golden, CO

Analyst – 1980 - 1990
Ledoux & Co. – Teaneck, NJ

Education

- BA in Literature – Ramapo College of NJ--Mahwah, NJ--1986

Professional Training

- Seminar- Conference on Customer Service, 2000
- Principles of Mass Spectrometry , 1991

Qualifications Summary

Ms. Culik has over 22 years experience in the environmental laboratory field. Experience includes analysis of drinking water utilizing a variety of organic and inorganic methods and Gas chromatography chemist on environmental samples. Experience also includes supervisor of the Gas Chromatography department responsible for analysis of environmental samples for pesticides/PCB's according to EPA/NYSDEC CLP Protocols, SW846 Methods and EPA "600" Series Methods.

Professional Experience

Quality Assurance Manager – 1991 to present

STL Connecticut (formerly IEA Incorporated)--Shelton, CT--1991 to Present

Ms Culik is responsible for developing and implementing the laboratory's quality system and laboratory quality manual to ensure compliance with STL policies for quality assurance and control (QA/QC). She administrates the laboratory certification and accreditation programs and responds to external audits. She is responsible for the assessment of operations through internal audits, management review and proficiency testing and for the oversight of preventative and corrective actions. Additional responsibilities include document control and archival of laboratory records. In addition, she prepares and submits monthly reports to corporate management, assists in reviewing project QA plans and serves as a laboratory/client support liaison.

Ms. Culik's responsibilities also include maintaining the laboratory's LIMS reporting system.

Gas Chromatography Group Leader

IEA Incorporated –Monroe, CT – 1986 to 1991

Chemist

York Laboratories – Monroe, CT – 1984 to 1986

Laboratory Analyst

American Waterworks Service Company – 1981 to 1984

Lab Technician

Suffolk County Water Authority 1978 to 1981

Lab Technician

Hooker Chemicals & Plastics – 1976 to 1978

Education

- AAS – Medical Technology, S.U.N.Y. at Alfred - Alfred, New York, 1976

Professional Training

- Two day seminar on Environmental Laboratory Management
  John H. Taylor, Analytical Technology.

- Performance Management Workshop
  One day seminar
  Cynthia Barnet, Human Resources Consultant

- Interview Skills Workshop
  One day seminar
  Cynthia Barnet, Human Resources Consultant

- Leadership Development Workshop
  Four day workshop
  William Frackler, Ingoldsby, Inc.

- Mass Spectral Data Interpretation
  One day seminar
  Dr. Frank Rutecek, Cornell University

- Introduction to Analytical Separations
  Four day seminar
  Dr. Dhea Habboush, Sacred Heart University

- ASQC Course
  Auditing of Quality Systems

- ASQC Course
  Introduction to SPC

- Six Sigma Green belt training

Professional Affiliations

Qualifications Summary

Mr. Helfrich has 15 years of experience in the environmental laboratory industry that includes extensive management/leadership experience with full profit and loss responsibility. He has functioned in numerous analytical roles including: Sample prep, furnace analysis, ICP analysis and hazardous waste coordinator. Experienced in data review, and familiar with EPA and NYSDEC protocols. He possesses excellent communication skills. Mr. Helfrich has an exceptional ability to effectively handle multiple projects and tasks. He is action-oriented, with a can-do attitude, a fast learner who has the capacity to adapt quickly to new situations.

Professional Experience

Inorganic Manager – 1998 to present

STL Connecticut - 1998 to Present
Mr. Helfrichs' responsibilities include the technical management of the inorganic analytical laboratory including approximately 10 chemists. The functional groups of the facility include Sample Preparation, Metals, General Inorganic Chemistry, and Report Generation. His other responsibilities include staff development and control, quality assurance and quality control of the inorganic departments, scheduling, as well as profit and loss responsibility for the Inorganic department. In addition, he is responsible for oversight of Waste Management and is part of the Environmental Health and Safety Program team.

Metals Manager
IEA INC – Monroe CT, 1992 to 1998

Metals Chemist
IEA INC – Monroe CT, 1989-1992

Education

- BS in Biology - St. Anselm College, Manchester NH, 1982
- MS in Chemistry - Quinnipiac College, Hamden CT, 1986
- MBA in Finance – Sacred Heart University, Fairfield CT, 1990

Qualifications Summary

Mrs. Maturo has over 19 years of experience in the environmental laboratory industry that includes extensive management/leadership experience.

She started in the Organic Extractions department as a lab technician and worked her way up to supervisor. From there, she transferred to the Gas Chromatography Department in order to expand her knowledge by learning more about the analysis of environmental samples. She is now Group Leader of the GC Department and is experienced in Pesticide and PCB residue analysis as well as a variety of other GC parameters.

Professional Experience

Gas Chromatography Group Leader-1991 to present

STL Connecticut (formery IEA, Inc.)-1991 to present
Mrs. Maturo is Supervisor of the Gas Chromatography Department. She is responsible for the analysis of environmental samples for Organochlorine and Organophosphorous pesticides, PCB's, Diesel Range Organics, and CT. Extractable Petroleum Hydrocarbons according to EPA/NYSDEC CLP Protocols, SW846 Methods and EPA "600" Series Methods.

Other duties include hiring personnel, ordering supplies, tracking samples thru the department, updating SOP's and final data package review.

GC- Senior Lab Technician

STL Connecticut (formerly IEA, formerly AEN)-1988 to 1991
Ms. Maturo's primary duties were the operation of gas chromatographs for a variety of analyses. She has experience in pesticide/PCB determinations as well as other miscellaneous analytes.

Other duties included sample tracking, data entry, report generation, and preparation of standards used for instrument calibration.

Extractions Technician/Extractions Group Leader

STL Connecticut (formerly YWC)-1988 to 1991
Over this time period Ms. Maturo was a member of the extractions group and supervised the operations and staff for the last year. Her duties were primarily extraction of environmental samples for semi-volatile organics, pesticides/PCB's and herbicides.
Other duties included preparation of standard reagents used in the extraction procedures, writing SOP's, and screening of sample extracts by gas chromatography.

Education

- BS in Biology – Southern Connecticut State University—New Haven, CT--1985

Professional Training

- Six Sigma Yellow Belt Management Training, 2003
- HAZWOPER Refresher-Field Safety Corp., 2000
- Perkin Elmer TurboChrom C/S Fundamentals Training Course, 1999
- Gas Chromatography Open Forum-Hewlett Packard, 1999
- "Dealing with Unacceptable Employee Behavior"- SkillPath Seminar, 1999
- Frontline Leadership-Zenger Miller, date Unknown
- 24 Hour Technician Course for Hazardous Waste Operations and Emergency Response-Field Safety Corp., 1999
- RCRA Compliant Hazardous Waste Handler Program-Field Safety Corp., 1999
- "Coaching and Teambuilding Skills for Managers and Supevisors"-SkillPath Seminar, date unknown
- Gas Chromatography Workshop-Env. Research Institute, UCONN., 1995
- "Basic Supervision"-SkillPath Seminar, 1988

Professional Affiliations

Qualifications Summary

Mr. Decker has 18 years of experience in the environmental laboratory industry that includes supervisory and leadership experience. He possesses extensive knowledge in volatile organic analyses and is a resource to the laboratory, project management and customers. He is an action-oriented manager with a can-do attitude; who has the capacity to adapt quickly to new situations.

Professional Experience

GC/MS Manager – 1992 to present

Mr. Decker's responsibilities include the management and overall production of the volatile organics laboratory including 3 employees and 7 analytical systems. Methodologies include SW-846, CLP, EPA 500 and 600 series methods. Other responsibilities include work scheduling, data review, method development and compliance and employee training. He is also proficient in the maintenance and troubleshooting of all analytical systems in his laboratory. In addition, he ensures conformance to STL Environmental Health and Safety and manages costs and expenditures incurred by his laboratory.

GC/MS Section Leader
Industrial Environmental Analysts—Monroe, CT—1991 to 1992

GC/MS Analyst
Industrial Environmental Analysts—Monroe, CT—1986 to 1991

Education

- BA in Biology – Franklin Pierce College—Rindge, NH --1982

Professional Training

- Mass Spectroscopy Data Interpretation – Dr. Frank Turecek
- GC/MS Software Training – Mark Hartwick
- HP User I Course – Hewlett-Packard
-

Professional Affiliations

American Chemical Society

Qualifications Summary

Mrs. May has 14 years of experience in the environmental laboratory industry that includes extensive experience in all phases of laboratory operations in the organic departments. She began as an analyst for GC volatile organics and quickly became responsible for the analysis of GC/MS volatiles, GC Pesticide/PCB and Herbicides, as well as GC/MS semi-volatiles. She also learned the extractions of all these analyses. She then changed companies to work in GC Pesticide/PCB/Herbicide/DRO analysis and reporting for SW-846 and CLP protocols. She became the Senior analyst in the department and was responsible for any troubleshooting issues with the instruments as well as system manager for the acquisition/analysis software system. She was then promoted to GC/MS Semivolatile Group leader and is now responsible for the day to day operation of the GC/MS Semi-Volatiles group.

Professional Experience

GC/MS Semi-volatile Group Leader – June 1, 2004 to present

STL Connecticut--Shelton, CT—June 1, 2004 to Present
Mrs. May's responsibilities include the supervision of 2 analyst's, sample tracking through the department, the analysis of semi-volatile extracts, target and non-target compound identification, instrument troubleshooting and maintenance, the reporting of data, and the final review of data packages. She provides guidance to staff to ensure that project specific data quality objectives are met. She ensures that the SOP's are updated and that the department is meeting protocol requirements.

GC Analyst II to IV/Reporting
STL Connecticut--Shelton, CT—April 1996 to June 2004

Responsiblities included data reporting as well as analysis of Pesticides, PCB's, Herbicides, CTETPH, DRO's, and Fingerprint Analysis. Responsible for troubleshooting and maintenance of all instrumentation as well as method development. She was the system manager for the Perkin Elmer Turbochrom software system. She perfomed data review of data packages.

GC/MS Semivolatile and Volatile analyst
Averill Environmental Laboratory—Plainville, CT--1993 to 1996

Responsible for the analysis and reporting of volatile and semi-volatile samples using SW-846 and drinking water methodologies. Responsible for the extraction of pesticides, PCB's, semi-volatile and TPH extracts.

GC Analyst
Averill Environmental Laboratory—Plainville, CT--1990 to 1996

Responsible for the analysis and reporting of Volatile, Pesticide, PCB, and Herbicide samples using SW-846 and drinking water methodologies.

Education

- BS in Renewable Natural Resources-Cum laude – University of Connecticut—Storrs, CT--1990

Professional Training

- Capillary Chromatography Training - 1996
- Turbochrom Client/Server System Manager – 2001
- Comprehensive Environmental GC Training - 2001
- RCRA Compliant Hazardous Waste Handler Program – 1999

Qualifications Summary

Ms. Haas has 7 years of experience in the environmental laboratory industry that includes management/leadership experience. Ms. Haas is responsible for the overall operations of the classical chemistry department. These responsibilities include but are not limited to meeting client satisfaction goals, managing the human resources within the department, and ensuring health and safety and quality assurance plan compliance. Ms. Haas serves as a technical resource to department employees, as well as project managers, sales personnel, and clients. She makes recommendations to laboratory management in regard to process improvements.

Professional Experience

Department Manager – Classical Chemistry – 2001 to present

STL Connecticut, Shelton, CT--2001 to Present
Ms. Haas' responsibilities include:

- Coordinating work projects with project managers to appropriately schedule laboratory workload to meet client requirements.
- Prioritizing samples for analysis to ensure that OTD and TAT requirements are met.
- Determining client-specific requirements and testing methodology; communicating requirements to analysts.
- Scheduling employees in regard to workload and backlog to improve efficiency.
- Supervising supervisors to maximize productivity and ensure appropriate testing procedures are used n compliance with QA and SOP requirements.
- Preparing and analyzing samples for analysis based on method requirements.
- Uploading data files to reporting system.
- Reviewing data produced in assigned department and authorizes its release.
- Communicating department issues and providing status reports to Laboratory Director and Projects Managers.
- Recommending process improvements to improve efficiency.
- Partnering with laboratory management to evaluate new work opportunities and plan implementation.

Classical Chemistry Laboratory Analyst/Data Manager

STL Connecticut, Shelton, CT--1997 to 2001

- Analyzed water and soil matrices using Standard Operation Procedures specific to the classical chemistry department.
- Performed tests such as total suspended and dissolved solids, pH, alkalinity, oil and grease, and hexavalent chromium using colorimetric, gravimetric, instrumental, and titrametric methods.
- Oversaw quality control of department.
- Prepared and reviewed client reports using raw data.
- Supervised data management staff.

Veterinary Technician
Mobile Veterinary Clinic, Trumbull, CT--1994-1997

- Performed diagnostic tests and procedures, such as radiographs and blood collection.
- Administered medical treatments.
- Provided surgical assistance and nursing care.
- Supervised kennel workers.
- Educated clients.

Campus Organizer
NJ Public Interest Research Group (NJPIRG), New Brunswick, NJ--1990-1993

- Organized student activities in NJPIRG chapter at Rutgers University.
- Created and implemented environmental programs, such as educating grade-school children about recycling.
- Lobbied for environmental legislation.
- Managed 100 student interns and volunteers.
- Developed relations with administration and faculty.

Education

- BS in Biology – Rutgers University—New Brunswick, NJ --1990

Qualifications Summary

Ms. Dubauskas has 24 years of experience in the environmental industry that includes extensive knowledge of laboratory, hazardous waste treatment and project management skills. She possesses excellent organizational and communication ability. Her enthusiasm for the highest achievable level of quality and customer service is apparent. Johanna has an exceptional capability to effectively handle multiple projects and tasks.

Professional Experience

Senior Project Manager – 1991 to present

STL Connecticut – Shelton, CT
Ms. Dubauskas' responsibilities include assisting clients in solving problems, answering client inquiries, discussing technical issues and managing clients through sampling programs with guidance on proper protocols. She is also responsible for scheduling sample pickups, coordinating incoming work within the laboratory, preparing written price quotations and invoicing. In addition, she assists Account Executives on sales calls and in project kick-off meetings.

Client Service Representative – 1987 to 1991
York Labs – Monroe, CT

Inside Sales Representative – 1986 to 1987
The Rockbestos Company – New Haven, CT

Chemical Buyer – 1985 to 1986
Pfaltz & Bauer – Waterbury, CT

Lab Technician – 1984 to 1985
Cecos Treatment Corporation – Bristol, CT

Research and Development Chemist –1983 to 1985
American Chemical and Refining, Inc. – Waterbury, CT

Chemist – 1980 to 1983
Environmental Waste Removal, Inc. – Waterbury, CT

Education

- BA in Biology – Western Connecticut State University – Danbury, CT - 1979

Professional Training

- Certificate Program of Environmental Science – 1985
- Customer Service Seminar - 2000

Qualifications Summary

Mrs. Duhancik has 6 years of experience in the environmental laboratory industry that includes project management and volatile organic compound GC/MS analysis experience. She possesses excellent communication and organizational skills. Jill has a passion for the highest achievable level of quality and customer service. She has an exceptional ability to effectively handle multiple projects and tasks. She is an action-oriented individual with a can-do attitude; a fast learner who has the capacity to adapt quickly to new situations. Jill is also adept at motivating a team to achieve goals and objectives.

Professional Experience

Project Manager – 2002 to present

STL Connecticut -Shelton, CT
Mrs. Duhancik's responsibilities include the coordination and management of customer's projects through all phases of laboratory operations, ensuring fulfillment of Severn Trent Laboratories commitments to client requirements, error-free work, and on-time delivery. She maintains communications with clients and Account Executives and serves as a liaison between clients and laboratory operations to meet client's needs. Mrs. Duhancik works closely with business unit personnel to manage quotations and change orders for existing scopes of work. She monitors compliance with industry regulations, contractual agreements, program management processes, and program specifications. She works towards achieving goals for revenue, profit, and KRI's through the effective utilization of laboratory capacity and definition of customer requirements.

VOA Analyst – 1998-2002
STL Connecticut – Shelton, CT

Waitress – 1996-1998
Olive Garden – Orange, CT

Education

- BS in Environmental Science – Saint Joseph College – West Hartford, CT -1998
- BS in Biology - Saint Joseph College – West Hartford, CT -1998

Qualifications Summary

Mr. Goodman has 3 years of experience in the environmental laboratory industry that includes Semivolatiles extractions and GC/MS analysis and management positions. He possesses excellent communication and writing skills. He has a passion for the highest achievable level of quality and customer service and the ability to effectively handle multiple projects and tasks. He is an action-oriented member of STL-CT with a can-do attitude; a fast learner who has the capacity to adapt quickly to new situations. He is also adept at motivating a team to achieve goals and objectives.

Professional Experience

Project Manager – 2004 to present

STL Connecticut – Shelton, CT--2004 to Present
Mr. Goodman's responsibilities include coordination and management of customers' projects through all phases of laboratory operations, ensuring fulfillment of Severn Trent Laboratories' commitments to client requirements, error-free work, and on-time delivery. Maintains communications with clients and Account Executives and serves as a liaison between clients and laboratory operations to meet client needs. Works closely with business unit personnel to manage quotations and change orders for existing scopes of work. Monitors compliance with industry regulations, contractual agreements, program management processes, and program specifications. Works toward achieving goals for revenue, profit, and customer service through the effective utilization of laboratory capacity and definition of customer requirements.

Extractions Manager
STL-Connecticut—Shelton, CT—02/2004 to 05/2004

Semivolatiles Analyst
STL-Connecticut—Shelton, CT—01/2002 to 02/2004

Extractions Analyst
STL-Connecticut—Shelton, CT—09/2001 to 02/2002

Education

- B.S. Environmental Science, St. Michael's College, Winooski Park, Colchester, VT May 2001.

APPENDIX, Section 2

ETHICS POLICY and QUALITY STATEMENT

SEVERN TRENT STL

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 non-authentic data by other employees;
- 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 will report this action immediately to a member of senior management, up to and including the President of STL; and
- I will not share the pricing or cost data of Vendors or Suppliers with anyone outside of the Severn Trent family of companies.

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 _____

Reference: STL Ethics Policy, P-L-006, Rev. 5.

SEVERN TRENT STL

Severn Trent Laboratories, Inc.

CONFIDENTIALITY AND PROPRIETARY INFORMATION AGREEMENT

Severn Trent Laboratories, Inc. and its predecessors, in their businesses, have developed and use commercially valuable technical and non-technical information and to guard the legitimate interests of STL and its clients, it is necessary to protect certain information as confidential and proprietary.

I, _____ , understand and acknowledge that during the term of my employment by STL, I will be privy to and entrusted with certain confidential information and trade secrets of STL and its clients.

Confidential information and trade secrets include, but are not limited to: customer and client lists; price lists; marketing and sales strategies and procedures; operational and equipment techniques; business plans and systems; quality control procedures and systems; special projects and technological research, including projects, research and reports for any government entity or client; client's plans and processes; client's manner of operation; the trade secrets of clients; client's data; vendor or supplier pricing; and any other records, data, files, drawings, inventions, discoveries, applications, or processes which are not in the public domain.

I agree as follows:

1. I will not in any way, during the term of my employment, or at any time thereafter, except as authorized in writing by the Legal Department of STL or the client where client data is involved, disclose to others, use for my own benefit, remove from STL's premises, copy or make notes of any confidential information and/or trade secrets of STL or its clients, excepting only that information which may be public knowledge. Technical and business information of any previous employer or other third party which I may disclose to STL shall be limited to that which was acquired legitimately and disclosed to me without restriction as to secrecy.

2. I agree that all inventions (whether or not patentable) conceived or made by me during the period of my employment by STL shall belong to STL, provided such inventions grow out of my work for STL and are related to the business of STL. I agree to disclose and assign such inventions to STL. In California, this provision shall not apply to any invention which qualifies fully under Section 2870 of the California Labor Code.

3. On termination of my employment from STL, I will deliver to STL all documents, records, notes, data, memoranda, files, manuals, equipment and things of any nature which relate in any way to confidential information and/or trade secrets of STL or its clients and which are in my possession or under my control.

4. I acknowledge that if I were to breach any provision of this Confidentiality Agreement, money damages will be inadequate, and I hereby agree that STL shall be entitled, where appropriate, to specific performance and/or injunctive relief (i.e. to require me to comply with this Agreement). I further acknowledge that the willingness of STL to hire me or to continue my employment constitutes full and adequate consideration for the agreements, and obligations to which I have agreed as set forth in this document.

I have executed this Agreement, intending to be legally bound.

_____	_____	_____
Printed Name	*Signature*	*Date*

Reference: STL Ethics Policy, P-L-006, Rev. 5.

APPENDIX, Section 3

CHAIN-OF-CUSTODY FORM

Chain of Custody Record

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

SEVERN TRENT **STL**

Severn Trent Laboratories, Inc.

STL-4124 (0901)

Client	Project Manager	Date	Chain of Custody Number 00019
Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page _____ of _____
City / State / Zip Code	Site Contact	Lab Contact	Analysis (Attach list if more space is needed)
Project Name and Location (State)	Carrier/Waybill Number		Special Instructions/ Conditions of Receipt
Contract/Purchase Order/Quote No.	Matrix	Containers & Preservatives	

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

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

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

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

QC Requirements (Specify)

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

Comments

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

APPENDIX, Section 4

STL SAMPLE PRESERVATION AND HOLDING TIME REQUIREMENTS

Parameter[1]	Methods	Matrix	Holding Time*	Container	Preservation
Inorganics-Metals					
Metals, excluding Hg	200 Series 7000 Series 6010	Water	6 months	500 ml P,G	HNO3 to PH <2
Mercury	200 Series 7000 Series	Water	28 Days	500 ml P,G	HNO3 to PH <2
Metals, excluding Hg	200 Series 7000 Series 6010	Soil	6 months	100 g P,G	Cool 4°C
Mercury	200 Series 7000 Series	Soil	28 Days	100 g P,G	Cool 4°C
Inorganics-Wet Chemistries					
Acidity	EPA 600	Water	14 Days	100 ml P,G	Cool 4°C
Alkalinity	EPA 600	Water	14 Days	100 ml P,G	Cool 4°C
BOD	EPA 600	Water	48 Hours	1000 ml P,G	Cool 4°C
Bromide	EPA 600	Water	28 Days	50 ml P,G	None Req.
COD	EPA 600	Water	28 Days	50 ml P,G	Cool 4°C, H2SO4 to pH <2
Chloride	EPA 600	Water	28 Days	50 ml P,G	None Req.
Chromium, CR+6	EPA 600	Water	24 Hours	50 ml P,G	Cool 4°C
Cyanide	EPA 600	Water	14 Days[2]	500 ml P,G	Cool 4°C, NaOH to pH > 12 Ascorbic Acid[3]
Fluoride	EPA 600	Water	28 Days	500 ml P,G	None Req.
Hardness	EPA 600	Water	6 Months	100 ml P,G	HNO3 to pH <2
MBAS	EPA 600	Water	48 Hours	500 ml P,G	Cool 4°C
Nitrogen-Ammonia	EPA 600	Water	28 Days	500 ml P,G	Cool 4°C, H2SO4 to pH <2
Nitrogen-TKN	EPA 600	Water	28 Days	500 ml P,G	Cool 4°C, H2SO4 to pH <2
Nitrate	EPA 600	Water	48 Hours	100 ml P,G	Cool 4°C
Nitrate-Nitrite	EPA 600	Water	28 Days	100 ml P,G	Cool 4°C, H2SO4 to pH <2

Parameter	Methods	Matrix	Holding Time*	Container	Preservation
Inorganics-Wet Chemistries-cont.					
Oil and Grease	EPA 600	Water	28 Days	1000 ml P,G	Cool 4°C, HCL or H2SO4 to pH <2
Petroleum Hydrocarbons	EPA 600-418.1	Water	28 Days	1000 ml P,G	Cool 4°C, HCL to pH <2
pH	EPA 600	Water	Immed.	50 ml P,G	NA
Phenols	EPA 600	Water	28 Days	500 ml P,G	Cool 4°C, H2SO4 to pH<2
Phosphorus, Ortho	EPA 600	Water	48 Hours	50 ml P,G	Filter Immed., Cool 4°C
Phosphorus,Total	EPA 600	Water	28 Days	50 ml P,G	Cool 4°C, H2SO4 to pH <2
Residue, TDS	EPA 600	Water	7 Days	100 ml P,G	Cool 4°C
Residue, TSS	EPA 600	Water	7 Days	250 ml P,G	Cool 4°C
Residue, TS	EPA 600	Water	7 Days	250 ml P,G	Cool 4°C
Residue, Volatile	EPA 600	Water	7 Days	250 ml P,G	Cool 4°C
Residue, Settleable	EPA 600	Water	48 Hours	250 ml P,G	Cool 4°C
Specific Conductance	EPA 600	Water	28 Days	100 ml P,G	Cool 4°C
Sulfate	EPA 600	Water	28 Days	250 ml P,G	Cool 4°C
Sulfide	EPA 600	Water	7 days	500 ml P,G	Cool 4°C, ZnAc/NaOH to pH >9
TOC	EPA 600	Water	28 Days	50 ml P,G	Cool 4°C, HCL or H2SO4 to pH <2
TOX	EPA 600	Water	28 Days	40 ml G	Cool 4°C, H2SO4 to pH <2, Sodium Sulfite
Turbidity	EPA 600	Water	48 Hours	100 ml P,G	Cool 4°C
Cyanide	SW846	Soil	14 Days	100 g G	Cool 4°C
Sulfide	SW846	Soil	7 Days	100 g G	Cool 4°C

Parameter	Methods	Matrix	Holding Time*	Container	Preservation
Organics-Parameters by Gas Chromatography					
Volatiles; Halogenated	600 series SW846	Water	7/14 Days[5]	3 x 40 ml vial	Cool 4°C, Thiosulfate[4]
Volatiles; Aromatics	600 series SW846	Water	7/14 Days[5]	3 x 40 ml vial	Cool 4°C, HCL to pH <2 Thiosulfate[4]
Volatiles; Non-Halogenated	SW846 - 8015	Water	7/14 Days[5]	3 x 40 ml vial	Cool 4°C, Thiosulfate[4]
Semi-volatiles	600 series SW846	Water	ext.- 7 Days anal.-40 Days	1L, amber G	Cool 4°C, Thiosulfate[4]
Organochlorine Pesticides/PCBs	600 series SW846	Water	ext.- 7 Days anal.-40 Days	1L, amber G	Cool 4°C, Thiosulfate[4]
Organophosphorus Pesticides	600 series SW846	Water	ext.- 7 Days anal.-40 Days	1L, amber G	Cool 4°C, Thiosulfate[4]
Herbicides	SW846	Water	ext.- 7 Days anal.-40 Days	1L, amber G	Cool 4°C, Thiosulfate[4]
Volatiles; Halogenated	SW846	Soil	14 Days	50 g, G	Cool 4°C
Volatiles; Aromatics	SW846	Soil	14 Days	50 g, G	Cool 4°C
Volatiles; Non-Halogenated	SW846 - 8015	Soil	14 Days	50 g, G	Cool 4°C
Semi-volatiles	SW846	Soil	ext.- 14 Days anal.-40 Days	100 g, G	Cool 4°C
Organochlorine Pesticides/PCBs	SW846	Soil	ext.- 14 Days anal.-40 Days	100 g, G	Cool 4°C
Organophosphorus Pesticides	SW846	Soil	ext.- 14 Days anal.-40 Days	100 g, G	Cool 4°C
Herbicides	SW846	Soil	ext.- 14 Days anal.-40 Days	100 g, G	Cool 4°C

Parameter	Methods	Matrix	Holding Time*	Container	Preservation
Organics-GC/MS Parameters					
Volatiles; Halogenated	600 series SW846	Water	7/14 Days[5]	3 x 40 ml vial	Cool 4°C, Thiosulfate[4]
Volatiles; Aromatics	600 series SW846	Water	7/14 Days[5]	3 x 40 ml vial	Cool 4°C, HCL to pH <2 Thiosulfate[4]
Volatiles; Halogenated	500 series	Water	7/14 Days[5]	3 x 40 ml vial	Cool 4°C, HCL to pH <2 Thiosulfate[4]
Volatiles; Aromatics	500 series	Water	7/14 Days[5]	3 x 40 ml vial	Cool 4°C, HCL to pH <2 Thiosulfate[4]
Semi-volatiles	600 series SW846	Water	ext.- 7 Days anal.-40 Days	1L, amber G	Cool 4°C, Thiosulfate[4]
Volatiles; Halogenated	SW846	Soil	14 Days	50 g, G	Cool 4°C
Volatiles; Aromatics	SW846	Soil	14 Days	50 g, G	Cool 4°C
Semi-volatiles	SW846	Soil	ext.- 14 Days anal.-40 Days	100 g, G	Cool 4°C

* From Collection

1. The following information is based upon WPA requirements outlines in Part 136, title 40 of the Code of Federal Regulations. Various state agencies have differing requirements for both holding times and preservation from those listed above. In such cases, the local requirements supersede the EPA information.

2. Maximum holding time is 24 hours when sulfide is present. Sample must be tested with lead acetate paper be fore pH adjustment in order to determine is sulfide is present.

3. If residual chlorine is present in the sample 0.6 g of ascorbic acid is utilized.

4. If samples contain residual chlorine sodium thiosulfate must be added at the time of sampling.

5. If samples do not received pH adjustment, the holding time is 7 days.

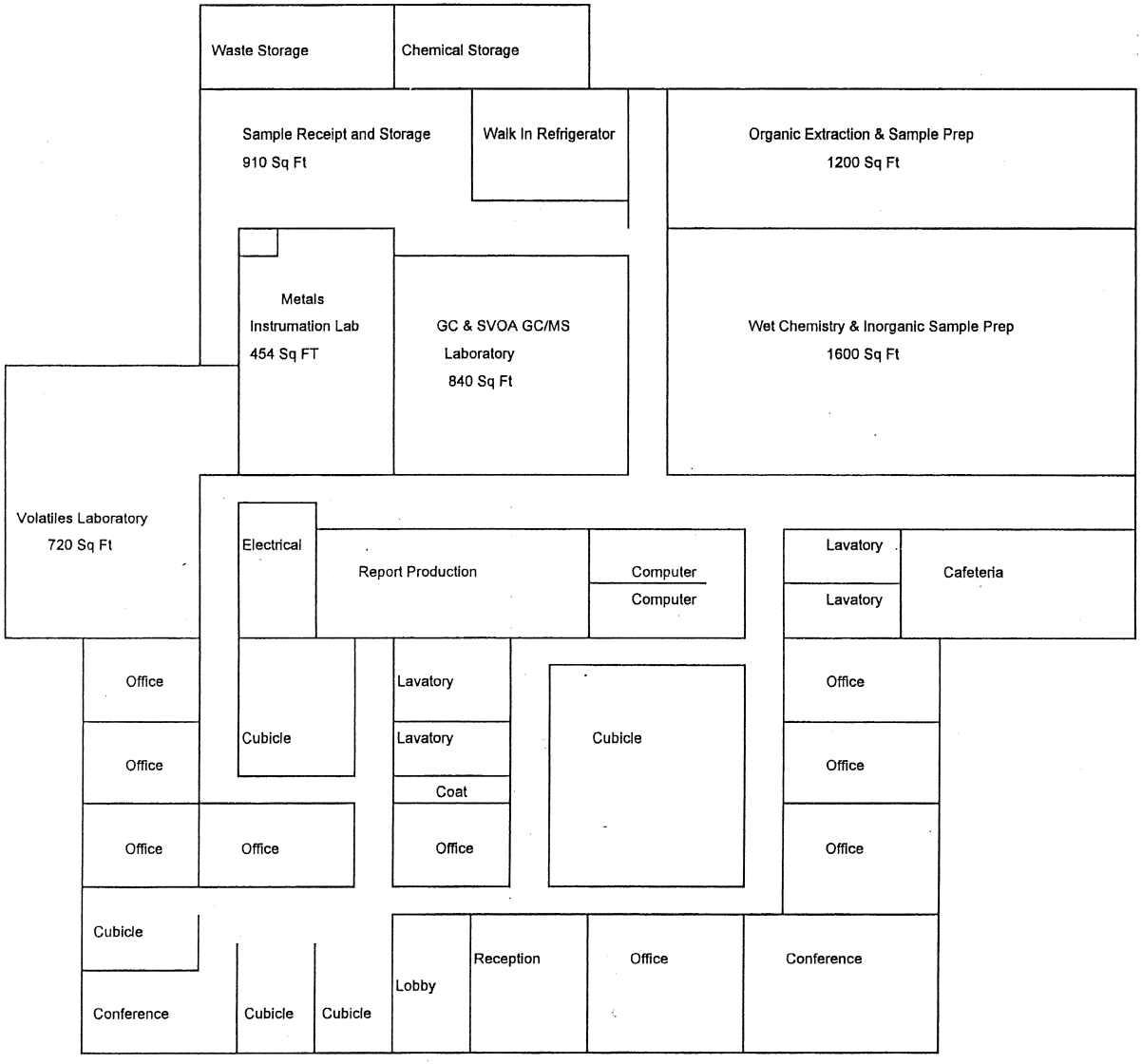
APPENDIX, Section 5

LABORATORY FLOOR PLAN

EQUIPMENT LIST

PREVENTIVE MAINTENANCE

Severn Trent Laboratories
Shelton, CT



STL CONNECTICUT LABORATORY
Instrument List

Instrument Type	Manufacturer	Model	Purchase Date	Autosampler	Method Performed
ICP	Thermo Jarrell Ash (61E) S/N 349490	61E ICAP	1994	Yes	6010B, 200.7
	Thermo Jarrell Ash (61P) S/N 464790	61E Trace	1997	Yes	6010B, 200.7
Mercury Analyzer	Perkin Elmer S/N 1398	FIMS	1999	Yes	7471A, 7470, 245.1
GC/MS Semivolatiles	Hewlett-Packard (U) S/N US33210086	5973/6890	2004	Yes	8270C, 625, SIM
	Hewlett-Packard (Q) S/N US00007319	5890/5971	1992	Yes	8270C, 625, SIM
	Hewlett-Packard (R) S/N US00036181	5890/5971	1992	Yes	8270C, 625, SIM
	Hewlett-Packard (P) S/N US00007291	5890/5971	1992	Yes	8270C, 625, SIM
GC/MS Volatiles	Hewlett-Packard (L) S/N 3240A18492	5890/5971	1992	Yes	8260B, 624
	Hewlett-Packard (K) S/N 3029A30026	5890/5970	1990	Yes	8260B, 624 – waters
	Hewlett-Packard (O) S/N 3203A41807	5890/5971	1991	Yes	8260B, 624 – waters
	Hewlett-Packard (N) S/N 3133A37851	5890/5971	1991	Yes	8260B, 624
	Hewlett-Packard (M) S/N 33033A33746	5890/5970	1991	Yes	8260B, 624 – soils
	Hewlett-Packard (T) S/N 3336A51317	5890/5972	1996	Yes	T0 17 – air
	Hewlett-Packard (v) S/N	6890/5973	2004	Yes	8260B, 624
GC Semivolatiles	Hewlett-Packard (GC1C/D) S/N	5890II - Dual ECD	1994	Yes	8081, 8082, 608
	Hewlett-Packard (GC4C/D) S/N 3033A33529	5890II - Dual ECD	1992	Yes	8082
	Hewlett-Packard (GC5C/D) S/N	5890II - Dual ECD	1989	Yes	8081, 8082, 608
	Hewlett-Packard (GC7C/D) S/N	5890II - Dual ECD	2004	Yes	8081, 8082, 608
	Hewlett-Packard (GC2C/D) S/N 3033A32099	5890II – FID/NPD	1991	Yes	WSO, 8141
	Hewlett-Packard (GC3) S/N 3033A32563	5890 - FID	1991	Yes	8015B (DRO), ETPH
Ion Chromatograph	Lachat S/N A83000-1476	Quickchem 8000	1999	Yes	300.0, 9056 350.1, 351.2 9012, 335.4, 353.2, 420.2
TOC	Dohrmann	Phoenix 8000	2004	No	415.2, 9060

STL CONNECTICUT LABORATORY
Instrument List

Instrument Type	Manufacturer	Model	Purchase Date	Autosampler	Method Performed
	Dohrmann	DC-190	1998	Yes	415.2, 9060
TKN Digestion System	Scientific Instruments	AD-4020	1994	No	351.2, 351.3
UV/VIS	Barnstead Turner	SP 830	2003	No	7196A, 376.2
UV/VIS	Buck Scientific	HC 404	2000	No	418.1
PH Meter	Orion Research	SA 720	1998	No	9040B, 9045C, 150.1
PH Meter	Beckman	12	1995	No	9040B, 9045C, 150.1
Autotitrator (pH, Alkalinity, Conductance)	Man-Tech (ATZ)	PC 1300	2003	Yes	9040B, 9045C, 150.1, 2320B, 310.1, 310.2, 2510B, 9050A, 120.1
Dissolved Oxygen Meter	YSI	51A	1994	No	405.1
Turbidimeter	HACH	2100 N	1990	No	180.1
Conductivity	Cole-Parmer	1484-20	1996	No	120.1
Automated Distillation Apparatus	Westco S/N 1028	1075 Easy Dist	2003	No	350.1, 420.2, 9066
COD	HACH	45600	1991	No	410.4
Flash Point Apparatus	Precision Scientific	Pensky-Martin	1990	No	1020
Midi Distillation Setups	Andrews Galss	110-10-R	1995	No	9012A, 335.1, 335.3
TCLP Spinners	Dayton	3M137B/5K939B	1990	No	1311, 1312
GPC	ABC	Autoprep 1000	1999	Yes	8270, 8081, 8082

STL- Connecticut LABORATORY PREVENTIVE MAINTENANCE

GC/MS SYSTEMS		
EQUIPMENT	ACTION PERFORMED	FREQUENCY
Hewlett-Packard 5970 MSD / 5971 MSD/5972 MSD	Check oil level in mechanical pumps	Weekly
	Change the oil in the mechanical pumps	Every 6 months
	Inspect the pump hoses and replace if required	Every 6 months
	Change oil in the turbo pump	Every 6 months
	Change exhaust trap absorbent	Every 6 months
	Inspect and refill the calibration sample vial with PFTBA	Every 6 months
	Vacuum fan grills and filters	Every 6 months
	Ion source cleaning and filament replacement	As needed
	Manual tuning	As needed
	Replace electron multiplier	As needed
	Clean out transfer line to GC	After every column removal
Hewlett-Packard 5890 GC	Check helium gas supply	Daily
	Change split vent trap	Every 3 months
	Column replacement and conditioning	As needed
	Column cutting and reinstallation	Daily or as needed
	Change helium gas cylinder	As needed
	Change liner and septum	Daily or as needed
	Clean injection port	As needed
EQUIPMENT	ACTION PERFORMED	FREQUENCY
Hewlett-Packard 7672A Autosampler	Inspect and correct injector alignment	After reseating
	Inspect syringe	Daily
	Check compressed air gas supply	Daily
	Inspect and adjust tension on sample tray	Daily
	Change rinse vials	Daily
	Change waste vials	Weekly
	Replace syringe	As needed
	Sand injector post	As needed
	Realign autosampler on brackets	As needed

	Change compressed air cylinder	As needed
Hewlett-Packard 7673A Autosampler	Inspect syringe	Daily
	Inspect seating of injector	Daily
	Change rinse vials	Daily
	Change waste vials	Weekly
	Replace syringe	As needed
	Reset control box	As needed
Tekmar Purge and Trap Sample Concentrators and Autosamplers	Inspect spargers and fittings	Daily
	Check purge flow	Daily
	Inspect line and valve temperatures	Daily
	Change and condition trap	As needed
	Adjust purge flow	As needed
	Rinse or clean sparging vessels	As needed
	Rinse sample lines	As needed
	Bake out trap	After each analysis, extend as needed
	Replace lines and fittings	As needed
	Adjust line and valve temperatures	As needed
EQUIPMENT	ACTION PERFORMED	FREQUENCY
Envirochem Air Sample Concentrator and AS	Inspect fittings	Daily
	Check flows	Daily
	Inspect line and valve temperatures	Daily
	Change and condition internal traps	As needed
	Adjust flow	As needed
	Bake out trap	After each analysis, extend as needed
	Replace lines and fittings	As needed
	Adjust line and valve temperatures	As needed
Archon	Check Syringe	Daily
	Check reagent water and waste bottles	Daily
	Autocalibrate robotic arm	As needed
	Replace inline filter	As needed

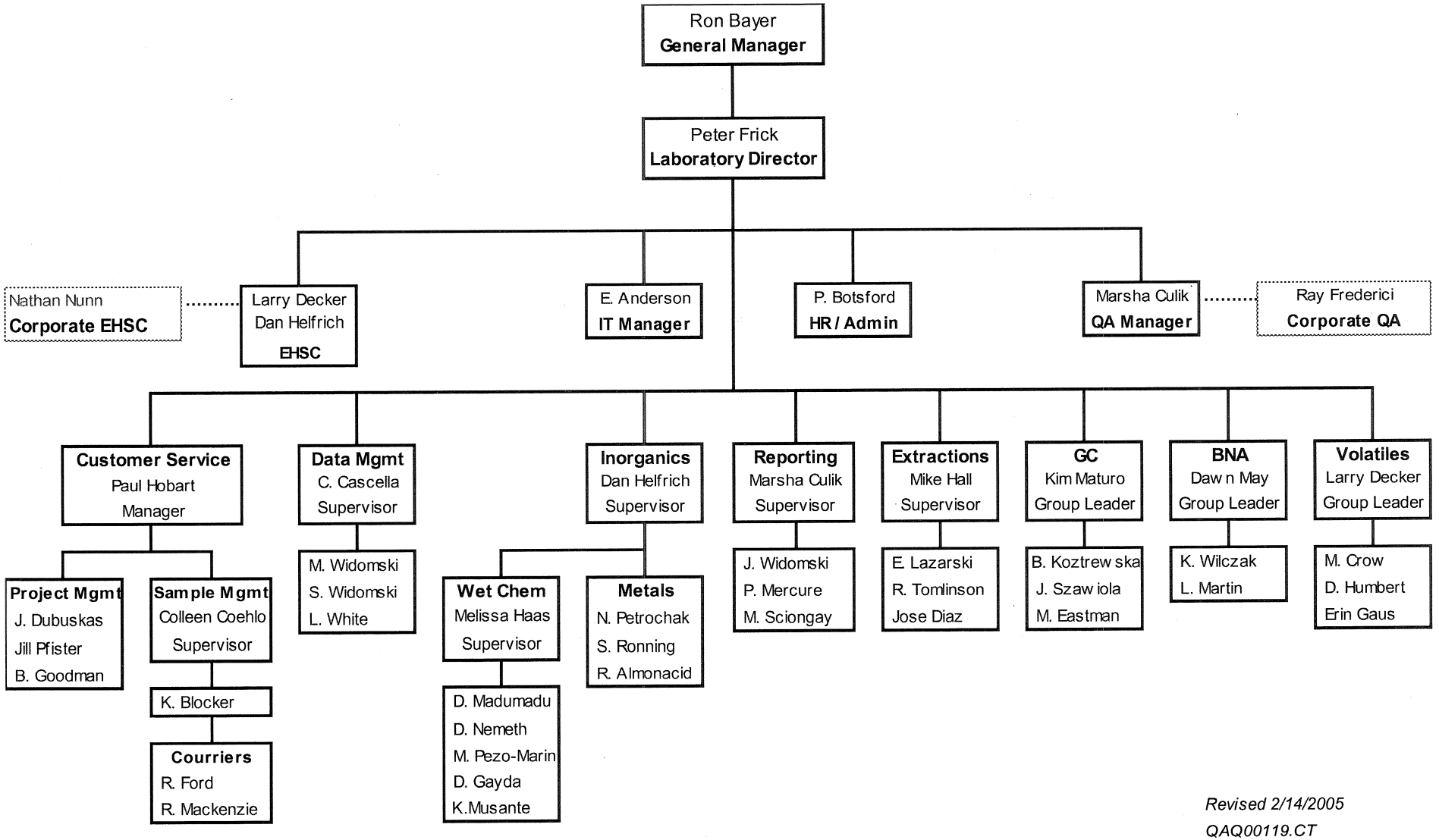
GC SYSTEMS		
EQUIPMENT	ACTION PERFORMED	FREQUENCY
Hewlett-Packard 5890A GC (GC-1,4,5 Dual ECD)	Check gas supply	Daily
	Check breakdown criteria	As required by run sequence
	Vacuum filters and grills	Quarterly
	Column replacement and conditioning	As needed
	Column cutting and reinstallation	As needed
	Change gas cylinders	As needed
	Change liner and septum	As needed
	Replace guard column	As needed
	Clean injection port	As needed
	Recondition ECD	As needed
	Change ECD vent absorbent traps	Quarterly
EQUIPMENT	ACTION PERFORMED	FREQUENCY
Hewlett-Packard 5890A GC (GC-3 FID/NPD)	Check gas supply	Daily
	Vacuum filters and grills	Quarterly
	Column replacement and conditioning	As needed
	Column cutting and reinstallation	As needed
	Change gas cylinders	As needed
	Change liner and septum	As needed
	Clean injection port	As needed
	Replace or reactivate the NPD collector	As needed
Hewlett-Packard 7673A Autosampler	Inspect syringe	Daily
	Inspect seating of injector	Daily
	Inspect rinse and waste vials	Daily
	Vacuum filters and grills	Quarterly
	Replace syringe	As needed
	Change rinse and waste vials	As needed

EQUIPMENT	ACTION PERFORMED	FREQUENCY
METALS SYSTEMS		
Inductively Coupled Plasma	Change capillary and pump tubing	Twice weekly
	Replace liquid argon tank	As required
	Reprofile via slit micrometer	Per manual
	Replace and realign plasma torch	As needed
	Clean nebulizer and spray chamber	As needed
	Check primary imaging mirror	Weekly
Mercury Analyzer	Clean sample cell and tubing	Monthly
	Check sparger condition	Daily
	Check level of mercury scrubber solution	Daily
	Replace lamps	As required
WET CHEMISTRY SYSTEMS		
EQUIPMENT	ACTION PERFORMED	FREQUENCY
pH Meters	Clean electrode if calibration has deteriorated	As needed
	Store pH electrodes in pH 7.0 buffer	Daily
	Check ISE electrodes and meter	Per manual
Analytical Balances	Surfaces cleaned and covered	Daily
	Calibrated and cleaned by manufacturer	Semi-annually
	Accuracy checked by class "S" weights	Prior to use
Conductivity Meters	Instrument surfaces inspected and cleaned	Daily
	Calibrated using 0.01M potassium chloride	Daily
	Spare cells on inventory	As needed
Spectrophotometers	Instrument cleaned	Daily use
Autoanalyzer Systems	Clean all components and flush system	Daily use
	Inspect all pump tubes and sample lines	Daily use
	Inspect line coils, heating baths and filters	Weekly
	Inspect all colorimeter filters	Weekly
	Inspect and clean chemical manifolds	Monthly

APPENDIX, Section 6

ORGANIZATIONAL CHART

STL Connecticut Organization



Revised 2/14/2005
QAQ00119.CT

SEVERN TRENT STL

Leaders in Environmental Testing

APPENDIX, Section 7

CORRECTIVE ACTION FORM

STL

CORRECTIVE ACTION FORM

A. Originator Information **Client Inquiry**

Client:_____ Job/Case:_____

Date/time:_____ Sample Number(s):_____

Client/Lab Contact: _____ Date/Time Response Due:_____

Detailed Description of Potential Problem:

_____

_____

_____

_____

_____

_____

_____

B. Quality Assurance Information **Corrective Action ID#** _____

Recommended Corrective Action:

_____

_____

_____

_____

Groups Involved:

__Sample Control __ Wet Chemistry __ Metals __Organic Extraction

__Gas Chromatography __ MS- VOA __ Report Generation __Lab Director

__Client Service __ MS -SV __EDD __ Subcontractor

C. Final Resolution

Describe What Happened and Corrective Action Taken:

_____

_____

_____

_____

Supervisor Signature: _____ Date_____ Date/Time Client Notified:_____

D. Quality Assurance Final Approval (QA Manager or designee use only)

Corrective Action Approved:_____

APPENDIX, Section 8

LISTING OF LABORATORY

STANDARD OPERATING PROCEDURES (SOPs)

Standard Operating Procedures Listing

Dept	Document Number	Revison	Active Date	SOP Title	Document Type
Sample Receipt	SMS00106.CT	6	09/05/04	Bottle Order Preparation	SOP
Sample Receipt	SMS00408.CT	8	09/06/04	Sample Processing and Sample Arrival	SOP
Sample Receipt	SMS00609.CT	9	09/06/04	Storing Water and Soil Samples	SOP
Sample Receipt	SMS00808.CT	8	09/06/04	Documenting Sample and Removal from the Laboratory	SOP
Sample Receipt	SMS00908.CT	8	09/06/04	Securing the Laboraotory and Samples	SOP
Sample Receipt	SMS01006.CT	6	09/06/04	Temperature Control Requirements	SOP
Sample Receipt	SMS01106.CT	6	09/06/04	Compositing, Homogenization and Splitting Environmental Samples	SOP
Sample Receipt	SMS01304.CT	4	09/06/04	Log-in for CLP (OLM04.2) Samples	SOP
Sample Receipt	SMS01402.CT	2	09/06/04	Sample Disposal	SOP
Sample Receipt	SMS01500.CT	0	09/04/04	Handling Samples under a Foreign Soil Permit	SOP
Organic Prep	SPS02804.CT	2	03/06/03	Preparation of Chlorinated Herbicides (W) - 8151A	SOP
Organic Prep	SPS01306.CT	6	05/15/02	Aqueous BNA Methods 3510/3520	SOP
Organic Prep	SPS01205.CT	5	04/25/02	Aqueous Pest/PCB Methods 3510C/3520C	SOP
Organic Prep	SPS01405.CT	5	09/01/02	Soil BNA Method 3550	SOP
Organic Prep	SPS01605.CT	5	06/20/02	Soil Pest/PCB Method 3550	SOP
Organic Prep	SPS01703.CT	3	05/15/02	Aqueous OP Pesticides Methods 3510/3520	SOP
Organic Prep	SPS01805.CT	5	04/03/02	SW846 GPC of BNA extracts	SOP
Organic Prep	SPS01902.CT	2	04/03/02	GPC of Pesticide/PCB extracts method 3640	SOP
Organic Prep	SPS02703.CT	3	09/05/02	Soil OP Pesticides Method 3550	SOP
Organic Prep	SPS03005.CT	5	04/02/02	Waste dilution - BNA	SOP
Organic Prep	SPS03103.CT	3	09/13/02	Waste dilution - Pesticides/PCB (3580)	SOP
Organic Prep	SPS03205.CT	5	05/15/02	Pesticide/PCB extraction method 608	SOP
Organic Prep	SPS03302.CT	2	09/05/02	Prep Soil/Sediment samples for CLP P/P OLM03.2	SOP
Organic Prep	SPS03401.CT	1	04/03/02	GPC of Pesticide extracts OLM03.2	SOP
Organic Prep	SPS03503.CT	3	02/21/03	Prep Soil/Sed samples for CLP BNA's OLM03.2	SOP
Organic Prep	SPS03601.CT	1	04/03/02	GPC of Semivolatile extracts OLM03.2	SOP
Organic Prep	SPS03701.CT	1	02/20/03	Prep of Aqueous samples for CLP BNA's OLM03.2	SOP
Organic Prep	SPS03802.CT	2	05/22/02	Prep of Aqueous samples for CLP P/P OLM03.2	SOP
Organic Prep	SPS03901.CT	1	06/18/97	CLP Extraction Standard Prep	SOP
Organic Prep	SPS02901.CT	1	07/26/96	Alumina Column C/U Method 3611A	SOP
Organic Prep	SPS04001.CT	1	06/05/02	Prep of Aqueous SV OLC10/92	SOP
Organic Prep	SPS04201.CT	1	09/18/02	Prep of Semivolatiles in Tissue samples	SOP
Organic Prep	SPS04305.CT	5	06/20/02	Prep of Pesticides/PCBs in Tissue samples	SOP
Organic Prep	SPS04403.CT	3	02/16/00	Prep of Chlorinated Herbicides -Method 8151 (S)	SOP

Standard Operating Procedures Listing

Dept	Document Number	Revison	Active Date	SOP Title	Document Type
Organic Prep	SPS04502.CT	2	09/18/02	Prep of PUF Samples for Pesticides/PCB T04	SOP
Organic Prep	SPS04602.CT	2	09/09/02	Prep of PUF Samples for Semi-volatiles T013	SOP
Organic Prep	SPS04703.CT	3	05/22/02	Prep of SV Method 625 (Water)	SOP
Organic Prep	SPS04801.CT	1	09/18/02	Prep of Wipe Samples Pesticides/PCBs	SOP
Organic Prep	SPS04903.CT	3	09/18/02	Florisil Cartridge clean-up P/P extracts	SOP
Organic Prep	SPS05002.CT	2	06/05/02	Prep of Low Level PCBs - Method 608	SOP
Organic Prep	SPS05101.CT	1	03/06/03	Prep of Low level PCBs - 3510C	SOP
Organic Prep	SPS05304.CT	4	06/05/02	Prep of Aqueous samples for DRO analysis - 8015B	SOP
Organic Prep	SPS05203.CT	3	06/20/02	Prep of Solid samples for DRO analysis - 8015B	SOP
Organic Prep	SPS05602.CT	2	02/13/03	Prep of Aqueous samples for CLP P/P OLM04.3	SOP
Organic Prep	SPS05702.CT	2	02/20/03	Prep of Soil/Sediment samples for CLP P/P OLM04.3	SOP
Organic Prep	SPS05802.CT	2	02/20/03	GPC CLP P/P Extracts OLM04.3	SOP
Organic Prep	SPS05902.CT	2	02/13/03	Standards Prep for CLP P/P OLM04.3	SOP
Organic Prep	SPS06002.CT	2	02/13/03	Prep of Aqueous samples for CLP BNA's OLM04.3	SOP
Organic Prep	SPS06102.CT	2	02/20/03	Prep of Solid samples for CLP BNA's OLM04.3	SOP
Organic Prep	SPS06202.CT	2	02/20/03	GPC of Semivolatile extracts OLM04.3	SOP
Organic Prep	SPS06301.CT	1	02/20/03	Standards Prep for CLP BNA OLM04.3	SOP
Organic Prep	SPS06400.CT	0	03/17/00	Standards Prep for CLP Pest/PCB OLM03.2	SOP
Organic Prep	SPS06500.CT	0	04/02/02	Prep of BNA Soils - Method 3541	SOP
Organic Prep	SPS06600.CT	0	09/10/02	Prep of Soil Samples for GC Method 3541	SOP
GCMS Semi VOA	MSS01604.CT	4	10/04/04	GC/MS Semivolatiles OLM03.2	SOP
GCMS Semi VOA	MSS02009.CT	9	10/10/04	GC/MS Analysis Method 625	SOP
GCMS Semi VOA	MSS02200.CT	0	10/05/04	GC/MS Semivolatile OLC2.1	SOP
GCMS Semi VOA	MSS02706.CT	6	08/19/04	GC/MS Semivolatile analysis - Method 8270C	SOP
GCMS Semi VOA	MSS03501.CT	1	09/14/04	GC/MS Semi-volatiles OLM04.3	SOP
GCMS Semi VOA	MSS03601.CT	1	10/08/04	GC/MS Semi-volatile screening OLM04.3	SOP
GCMS Semi VOA	MSS03701.CT	1	10/07/04	Semi-volatile Std Prep	SOP
GCMS Semi VOA	MSS03400.CT	0	01/21/03	Semi-volatile by Method T0 13A	SOP
GCMS VOA	MSS00100.CT	0	04/30/93	Volatile Std Prep CLP	SOP
GCMS VOA	MSS01500.CT	0	dft	GC/MS Volatile 524.2 Rev. 3	SOP
GCMS VOA	MSS01801.CT	1	06/27/97	GC/MS Volatiles OLM03.2	SOP
GCMS VOA	MSS02102.CT	2	02/15/00	GC/MS Analysis Method 624	SOP
GCMS VOA	MSS02803.CT	3	09/23/03	GC/MS Volatile analysis - Method 8260B	SOP
GCMS VOA	MSS02900.CT	0	dft	GC/MS Volatiles - OLC02.1	SOP
GCMS VOA	MSS03001.CT	1	03/27/03	GC/MS VOA OLM04.3	SOP

Standard Operating Procedures Listing

Dept	Document Number	Revison	Active Date	SOP Title	Document Type
GCMS VOA	MSS03300.CT	0	01/27/00	GC/MS Volatile Standards Prep OLM04.2	SOP
GCMS VOA	MSS03802.CT	2	01/24/05	Volatile by Method T0 17	SOP
GC Semivoa	GCS00302.CT	2	01/13/04	Sulfur Removal	SOP
GC Semivoa	GCS00504.CT	4	01/13/04	Analysis of OP Pesticides Method 8141A	SOP
GC Semivoa	GCS00703.CT	3	02/18/04	Misc. Volatiles Method 8015 (DAI)	SOP
GC Semivoa	GCS01302.CT	2	01/13/04	Analysis of Hydrocarbon Fingerprinting	SOP
GC Semivoa	GCS01104.CT	4	01/20/04	Pesticides/PCB Method 608	SOP
GC Semivoa	GCS01503.CT	3	01/13/04	GC/ECD Pesticides/PCB analysis OLM03.2	SOP
GC Semivoa	GCS01804.CT	4	01/13/04	Diesel Range Organics - Method 8015B	SOP
GC Semivoa	GCS02003.CT	3	01/19/04	Pesticide/PCB analysis - Method T04	SOP
GC Semivoa	GCS02104.CT	4	01/13/04	Water soluble Organics - DAI/NPD	SOP
GC Semivoa	GCS02205.CT	5	01/14/04	Analysis of Pesticides - Method 8081A	SOP
GC Semivoa	GCS02306.CT	6	01/14/04	Analysis of PCBs - Method 8082	SOP
GC Semivoa	GCS02403.CT	3	01/20/04	Analysis of Herbicides - Method 8151A	SOP
GC Semivoa	GCS02503.CT	3	01/20/04	GC/ECD Pesticides/PCB CLP OLM04.3	SOP
GC Semivoa	GCS02603.CT	3	01/20/04	Pesticide/PCB Standard Prep OLM04.3	SOP
GC Semivoa	GCS02702.CT	2	01/13/04	CT ETPH - DRO	SOP
Metals	MES00906.CT	6	04/01/04	SW846 Method 3010A	SOP
Metals	MES01006.CT	6	04/01/04	SW846 Method 3050B	SOP
Metals	MES02001.CT	1	01/20/03	Method 6010B - TJA61 Trace ICP	SOP
Metals	MES02201.CT	1	02/12/00	Metals Digestion ILM04.1 (Water)	SOP
Metals	MES02301.CT	1	02/12/00	Metals Digestion ILM04.1 (Soil)	SOP
Metals	MES02401.CT	1	02/12/00	Determination of Mercury in Water ILM04.1	SOP
Metals	MES02501.CT	1	02/12/00	Determination of Mercury in Soil ILM04.1	SOP
Metals	MES02601.CT	1	03/22/00	Determination of Metals - ILM04.1 TJA-61E Trace	SOP
Metals	MES02700.CT	0	08/01/96	Determination of Metals - 200.7 TJA 61E Trace	SOP
Metals	MES02800.CT	0	08/01/96	Determination of Mercury in Water Method 245.1	SOP
Metals	MES02900.CT	0	dft	Metals Digestion of Wipe Samples	SOP
Metals	MES03103.CT	3	03/27/03	Mercury 7470A (Hot Block)	SOP
Metals	MES03202.CT	2	01/20/03	Mercury 7471A (Hot Block)	SOP
Metals	MES03301.CT	1	07/12/02	Metals Digestion 200.7 (Water)	SOP
Wet Chemistry	CVS01004.CT	4	01/28/04	Analysis of Oil & Grease (Gravimetric)- 413.1	SOP
Wet Chemistry	WC:070891:0	0	07/08/91	Analysis of Salinity in Water	SOP
Wet Chemistry	CVS04301.CT	1	02/26/99	Measurement of Conductivity	SOP
Wet Chemistry	WC:071691:0	0	07/16/91	Analysis of Dissolved Oxygen in Water	SOP

Standard Operating Procedures Listing

Dept	Document Number	Revison	Active Date	SOP Title	Document Type
Wet Chemistry	CVS00706.CT	6	10/14/04	Analysis of Alkalinity in Water - 310.1	SOP
Wet Chemistry	CVS02603.CT	3	10/14/04	Analysis of Ammonia (method 350.2) in Water	SOP
Wet Chemistry	CVS00900.CT	0	03/31/94	Measurement of pH	SOP
Wet Chemistry	CVS01705.CT	5	10/14/04	Analysis of Sulfide	SOP
Wet Chemistry	CVS00506.CT	6	01/23/04	Analysis of Biochemical Oxygen Demand	SOP
Wet Chemistry	CVS01205.CT	5	02/17/04	Analysis of COD (Method 410.4)	SOP
Wet Chemistry	CVS01101.CT	1	02/04/00	Analysis of Samples for Total Cyanide CLP Protocol	SOP
Wet Chemistry	CVS01502.CT	2	10/8/1999	SOP for Toxicity Characteristic Leaching Procedure - 1311	SOP
Wet Chemistry	CVS04003.CT	3	4/10/2000	Measurement of Turbidity in Water Samples	SOP
Wet Chemistry	CVS00103.CT	3	10/26/1999	Analysis of Total Dissolved Solids in Water	SOP
Wet Chemistry	CVS03403.CT	3	10/19/2004	Analysis of TOC Soil Samples	SOP
Wet Chemistry	CVS03902.CT	2	10/8/1999	Analysis of Chloride (325.2) in Water	SOP
Wet Chemistry	CVS01901.CT	1	10/9/1999	Standard Operating Procedure for Reactivity	SOP
Wet Chemistry	CVS04603.CT	3	6/8/2004	Standard Operating Procedure for Corrosivity	SOP
Wet Chemistry	CVS02303.CT	3	10/19/2004	Standard Operating Procedure for Ignitability (1030)	SOP
Wet Chemistry	CVS00204.CT	4	1/21/2004	Analysis of Total Suspended Solids in Water	SOP
Wet Chemistry	CVS02502.CT	2	10/8/1999	Analysis of Nitrate and Nitrite for Water Samples (Method 353.2)	SOP
Wet Chemistry	CVS02002.CT	2	10/20/2004	SOP for Total Cyanide - Method 335.4	SOP
Wet Chemistry	CVS02102.CT	2	10/4/2004	SOP for Amenable Cyanide - Method 335.1	SOP
Wet Chemistry	CVS00300.CT	0	08/21/93	SOP for Total Solids	SOP
Wet Chemistry	CVS02900.CT	0	3/20/1995	SOP for CEC Method 9081	SOP
Wet Chemistry	CVS03000.CT	0	3/20/1995	SOP for Soil Homogenization	SOP
Wet Chemistry	CVS03303.CT	3	10/19/2004	SOP for Oxidation -Reduction Potential	SOP
Wet Chemistry	CVS03700.CT	0	10/10/1996	SOP for The Determination of Ferrous Iron	SOP
Wet Chemistry	CVS02403.CT	3	10/20/2004	SOP for Phenols method 420.1/420.2	SOP
Wet Chemistry	CVS04100.CT	0	1/6/1997	SOP for Determination of Percent Solids	SOP
Wet Chemistry	CVS04504.CT	4	6/8/2004	SOP for Oil and Grease - Method 1664A	SOP
Wet Chemistry	CVS04703.CT	3	10/20/2004	SOP for Total Petroleum Hydrocarbons - Method 418.1	SOP
Wet Chemistry	CVS04804.CT	4	10/27/2004	SOP for Analysis of Total Phosphorus	SOP
Wet Chemistry	CVS04902.CT	2	11/1/1999	SOP for Sample Screening for Chorine Residual	SOP
Wet Chemistry	CVS05203.CT	3	10/28/2004	SOP for Chlorine Residual	SOP
Wet Chemistry	CVS05102.CT	2	10/28/2004	SOP for Reagent Water Monitoring	SOP
Wet Chemistry	CVS05303.CT	3	11/2/2004	SOP for Ferrous Iron (SM4500)	SOP

Standard Operating Procedures Listing

Dept	Document Number	Revison	Active Date	SOP Title	Document Type
Wet Chemistry	**CVS05005.CT**	5	11/2/2004	SOP for Hexavalent Chromium – 7196A	SOP
Wet Chemistry	**CVS05401.CT**	1	5/16/2002	SOP for Total Cyanide – 9012A	SOP
Wet Chemistry	**CVS05500.CT**	0	9/10/1999	SOP for CC Labeling /Coding of Standards	SOP
Wet Chemistry	**CVS05601.CT**	1	05/16/02	Total Sulfide (W/S) 9030B	SOP
Wet Chemistry	**CVS05701.CT**	1	10/07/02	Paint Filter	SOP
Wet Chemistry	**CVS05802.CT**	2	01/29/04	SOP for pH of Soil	SOP
Wet Chemistry	**CVS06000.CT**	0	04/25/00	SOP for TKN (351.2)	SOP
Wet Chemistry	**CVS06100.CT**	0	04/25/00	SOP for Ion Chromatography –9065/300	SOP
Wet Chemistry	**CVS06200.CT**	0	05/21/01	SOP for SPLP Preparation (SW846 1312)	SOP
Wet Chemistry	**CVS06400.CT**	0	03/12/03	SOP for Flashpoint 1020	SOP
Wet Chemistry	**CVS06301.CT**	1	02/12/03	SOP for Cyanide – ILM05.2	SOP
Wet Chemistry	**CVS06500.CT**	0	05/23/03	SOP for Color	SOP
Wet Chemistry	**CVS06600.CT**	0	08/20/03	SOP for Hardness	SOP
Wet Chemistry	**CVS06700.CT**	0	02/12/04	SOP for TPH-IR Soils – Soxtherm	SOP
Wet Chemistry	**CVS07000.CT**	0	01/26/04	SOP for Autotitrator	SOP
Wet Chemistry	**CVS07100.CT**	0	11/02/04	SOP for TOC -water Phoenix 8000	SOP
Information Systems	**SYS01900.CT**	0	04/23/97	SOP for GC/MS Chemserver Archive	SOP
Information Systems	**SYS02000.CT**	0	01/20/98	SOP for Generating Standard E-mail Result Files	SOP
Information Systems	**SYS02300.CT**	0	04/08/02	SOP for GC Target Deliverables	SOP
Information Systems	**SYS02400.CT**	0	07/22/02	SOP for GC Labnet Deliverables	SOP
Information Systems	**SYS02500.CT**	0	DFT	SOP for GC/MS VOA Target Deliverables	SOP
Information Systems	**SYS02600.CT**	0	DFT	SOP for GC/MS VOA Labnet Deliverables	SOP
Project Management	**MKS00101.CT**	1	03/06/99	SOP for Taking Client Orders	SOP
Project Management	**MKS00201.CT**	1	03/06/99	SOP for LIMS Log-in	SOP
Project Management	**MKS00400.CT**	0	06/22/94	SOP for Telephone Logs	SOP
Quality Assurance	**QAS00305.CT**	5	02/12/03	SOP for Document Control	SOP
Quality Assurance	**QAS00504.CT**	4	02/10/03	SOP for Corrective Action Reports	SOP
Quality Assurance	**QAS00803CT**	3	2/10/2003	SOP for Generating SOPs	SOP
Quality Assurance	**QAS00901.CT**	1	1/27/2001	SOP for Balance Calibraton	SOP
Quality Assurance	**QAS01003.CT**	1	10/1/2004	SOP for Document coding, Approval and Revisions	SOP
Quality Assurance	**QAS01101.CT**	1	2/23/1999	SOP for Thermometer Calibration	SOP
Quality Assurance	**QAS01301CT**	1	1/10/2003	SOP for Corrections to Lab Documents	SOP
Quality Assurance	**QAS01201.CT**	1	4/10/2000	SOP for Temperature Monitoring of Lab Equipment	SOP
Quality Assurance	**QAS01501.CT**	1	3/15/2001	SOP for Glassware Cleaning	SOP
Quality Assurance	**QAS01601.CT**	1	6/1/2003	SOP for Employee Training	SOP

Standard Operating Procedures Listing

Dept	Document Number	Revison	Active Date	SOP Title	Document Type
Quality Assurance	**QAS01700.CT**	0	02/22/99	SOP for Conducting MDL Studies	SOP
Quality Assurance	**QAS01800.CT**	0	03/01/99	SOP for Reagent Control and Coding	SOP
Quality Assurance	**QAS01900.CT**	0	09/01/99	SOP for Terms and Definitions	SOP
Quality Assurance	**QAS02001.CT**	1	02/12/03	SOP for PT Testing	SOP
Quality Assurance	**QAS02102.CT**	2	02/24/03	SOP for Maintenance logs	SOP
Quality Assurance	**QAS02200.CT**	0	04/10/00	SOP for Sample Prep for MEOH preserved Volatiles	SOP
Quality Assurance	**QAS02400.CT**	0	05/01/04	SOP for Independent QA Review	SOP
Report Preparation	**RPS00304.CT**	4	04/25/00	Preparation and Review of Laboratory Reports	SOP
Report Preparation	**RPS00400.CT**	0	03/21/95	Report Retrieval	SOP
Report Preparation	**RPS00600.CT**	0	10/07/04	EDD Generation	SOP
Health and Safety	**SFS00202.CT**	2	06/03/02	Operating and Maintaining Fume Hoods	SOP
Health and Safety	**SFS00101.CT**	1	01/14/05	Tracking and Collection of Hazardous Waste	SOP
Radiological	**RAS00102.CT**	2	06/03/02	Tracking and Collection of Mixed Waste	SOP
Radiological	**RAS00202.CT**	2	06/03/02	Radioactivity Swipe Tests	SOP
Radiological	**RAS00302.CT**	2	06/03/02	Radiation Screening	SOP
Radiological	**RAS00400.CT**	0	08/24/94	Management/Disposal of Mixed Waste	SOP

APPENDIX, Section 9

LISTING OF ANALYTICAL CAPABLITIES

STL Analytical Capabilities List

STL Connecticut

Program	Technique	Analyte Group	Method ▲	Source	Description
Solid & Hazardous Waste	Waste Characterization	Waste Characterization	1020A	SW-846	Flashpoint (Setaflash)
Solid & Hazardous Waste	Waste Characterization	Waste Characterization	1030	SW-846	Ignitability of Solids
Solid & Hazardous Waste	Waste Characterization	Waste Characterization	1030	SW-846	Flashpoint of Solids
Non-potable Water	Colorimetric	General Chemistry	110.2	EPA	Color
Non-potable Water	Electrometric	General Chemistry	120.1	EPA	Conductance, Specific
Solid & Hazardous Waste	TCLP	Leach	1311	SW-846	Toxicity Characteristic Leachate Procedure
Solid & Hazardous Waste	SPLP	Leach	1312	SW-846	Synthetic Precipitate Leachate Procedure
Non-potable Water	General Chemistry	General Chemistry	140.1	EPA	Odor
Drinking Water	Electrometric	General Chemistry	150.1	EPA	pH
Non-potable Water	Electrometric	General Chemistry	150.1	EPA	pH
Non-potable Water	Gravimetric	Residue Testing, solids	160.1	EPA	Solids, Total Dissolved
Non-potable Water	Gravimetric	Residue Testing, solids	160.2	EPA	Solids, Total Suspended
Non-potable Water	Gravimetric	Residue Testing, solids	160.3	EPA	Solids, Total
Non-potable Water	Gravimetric	Residue Testing, solids	160.3	EPA	Moisture, Percent (%)
Non-potable Water	Gravimetric	Residue Testing, solids	160.4	EPA	Solids, Total Volatile
Non-potable Water	Gravimetric	Residue Testing, solids	160.4	EPA	Solids, Volatile Suspended
Non-potable Water	Gravimetric	General Chemistry	160.5	EPA	Solids, Settleable
Non-potable Water	Gravimetric	Residue Testing, solids	160.5	EPA	Solids, Settleable
Non-potable Water	Gravimetric	Hydrocarbons	1664A	EPA	Oil & Grease
Non-potable Water	Turbidimetric	General Chemistry	180.1	EPA	Turbidity
Drinking Water	Turbidimetric	General Chemistry	180.1	EPA	Turbidity
Drinking Water	ICP	Metals	200.7	EPA	ICP Metals
Non-potable Water	ICP	Metals	200.7	EPA	ICP Metals
Non-potable Water	Calculation	General Chemistry	200.7	EPA	Hardness (calculation from ICP results)
CLP	ICP	Metals	200.7 CLP-M	CLP ILM04.0	ICP Metals
Non-potable Water	General Chemistry	General Chemistry	2120B	SM	Color
Drinking Water	General Chemistry	General Chemistry	2120B	SM	Color
Non-potable Water	Turbidimetric	General Chemistry	2130 B	SM	Turbidity

Drinking Water	Turbidimetric	General Chemistry	2130 B	SM	Turbidity
Non-potable Water	Titrimetric	General Chemistry	2320 B	SM	Alkalinity, Hydroxide
Non-potable Water	Titrimetric	General Chemistry	2320 B	SM	Alkalinity, Bicarbonate
Non-potable Water	Titrimetric	General Chemistry	2320 B	SM	Alkalinity, Total
Non-potable Water	Titrimetric	General Chemistry	2320 B	SM	Alkalinity, Carbonate
Drinking Water	Titrimetric	General Chemistry	2320B	SM	Alkalinity, Bicarbonate
Drinking Water	Titrimetric	General Chemistry	2320B	SM	Alkalinity, Total
Drinking Water	Titrimetric	General Chemistry	2320B	SM	Alkalinity, Carbonate
Non-potable Water	Calculation	General Chemistry	2340B	SM	Hardness
Drinking Water	Calculation	General Chemistry	2340B	SM	Hardness (by calculation)
Non-potable Water	CVAA	Metals	245.1	EPA	Mercury-Hg (cold vapor)
Drinking Water	CVAA	Metals	245.1	EPA	Mercury-Hg (cold vapor)
CLP	CVAA	Metals	245.1 CLP-M	CLP ILM04.0	Mercury-Hg (water by manual cold vapor)
CLP	CVAA	Metals	245.5 CLP-M	CLP ILM04.0	Mercury-Hg (soil by manual cold vapor)
Drinking Water	Electrometric	General Chemistry	2510B	SM	Conductance, Specific
Non-potable Water	Electrometric	General Chemistry	2510B	SM	Conductance, Specific
Non-potable Water	Gravimetric	General Chemistry	2520B	SM	Salinity
Non-potable Water	Gravimetric	Residue Testing, Solids	2540 B	SM	Solids, Total
Drinking Water	Gravimetric	Residue Testing, Solids	2540 C	SM	Solids, Total Dissolved
Non-potable Water	Gravimetric	Residue Testing, Solids	2540 C	SM	Solids, Total Dissolved
Non-potable Water	Gravimetric	Residue Testing, Solids	2540 D	SM	Solids, Total Suspended
Non-potable Water	General Chemistry	General Chemistry	2710D	SM	Sludge Volume Index
Non-potable Water	Ion Chromatography	Anions	300	EPA	Phosphate (Ortho)
Non-potable Water	Ion Chromatography	Anions	300	EPA	Sulfate, as SO4
Non-potable Water	Ion Chromatography	Anions	300	EPA	Nitrite-Nitrogen
Non-potable Water	Ion Chromatography	Anions	300	EPA	Nitrate-Nitrogen
Non-potable Water	Ion Chromatography	Anions	300	EPA	Anions, by IC (Br, PO4, SO4, NO3, NO2,Cl, F)
Non-potable Water	Ion Chromatography	Anions	300	EPA	Fluoride
Non-potable Water	Ion Chromatography	Anions	300	EPA	Nitrate/Nitrite
Non-potable Water	Ion Chromatography	Anions	300	EPA	Chloride
Non-potable Water	Ion Chromatography	Anions	300	EPA	Bromide
Drinking Water	Ion Chromatography	Anions	300.0	EPA	Phosphate (Ortho)
Drinking Water	Ion Chromatography	Anions	300.0	EPA	Anions, by IC (Br, PO4, SO4, NO3, NO2,Cl, F)
Drinking Water	Ion Chromatography	Anions	300.0	EPA	Nitrite-Nitrogen
Drinking Water	Ion Chromatography	Anions	300.0	EPA	Nitrate/Nitrite
Drinking Water	Ion Chromatography	Anions	300.0	EPA	Fl Fluoride (IC)

Drinking Water	Ion Chromatography	Anions	300.0	EPA	Sulfate, as SO4
Drinking Water	Ion Chromatography	Anions	300.0	EPA	Nitrate-Nitrogen
Drinking Water	Ion Chromatography	Anions	300.0	EPA	Chloride
Solid & Hazardous Waste	Digestion	Metals	3010A	SW-846	Acid Digest of Aqueous Samples for Total Metals FLAA& ICP
Solid & Hazardous Waste	Digestion	Metals	3050B	SW-846	Acid Digest of Sediments, Sludges & Soils
Non-potable Water	Titrimetric	General Chemistry	310.1	EPA	Alkalinity, Bicarbonate
Non-potable Water	Titrimetric	General Chemistry	310.1	EPA	Alkalinity, Hydroxide
Drinking Water	Titrimetric	General Chemistry	310.1	EPA	Alkalinity, Carbonate
Drinking Water	Titrimetric	General Chemistry	310.1	EPA	Alkalinity, Hydroxide
Non-potable Water	Titrimetric	General Chemistry	310.1	EPA	Alkalinity, Total
Drinking Water	Titrimetric	General Chemistry	310.1	EPA	Alkalinity, Total
Non-potable Water	Titrimetric	General Chemistry	310.1	EPA	Alkalinity, Carbonate
Drinking Water	Titrimetric	General Chemistry	310.1	EPA	Alkalinity, Bicarbonate
Non-potable Water		Hydrocarbons	310.13	NY	Petroleum Hydrocarbons (TPHC)
Drinking Water	Spectrophotometric	General Chemistry	330.5	EPA	Chlorine Residual
Non-potable Water	Spectrophotometric	General Chemistry	330.5	EPA	Chlorine Residual, DPD
Non-potable Water	Spectrophotometric	Cyanides	335.1	EPA	Cyanide, Amenable to Chlorination
CLP	Spectrophotometric	Cyanides	335.2 CLP-M	CLP ILM04.0	Cyanide, Total
Drinking Water	Spectrophotometric	Cyanides	335.4	EPA	Cyanide, Total
Non-potable Water	Spectrophotometric	Cyanides	335.4	EPA	Cyanide, Total (Semi-automated)
Drinking Water	Colorimetric	Nitrogen Series	350.1	EPA	Ammonia, Nitrogen (w. distillation)
Non-potable Water	Spectrophotometric	Nitrogen Series	350.1	EPA	Ammonia, Nitrogen (w. distillation)
Non-potable Water	Spectrophotometric	Nitrogen Series	350.1	EPA	Ammonia, Nitrogen (Automated phenate)
Non-potable Water	Spectrophotometric	Nitrogen Series	350.1	EPA	Nitrogen, Total Organic (TON), automated phenate
Drinking Water	Colorimetric	Nitrogen Series	350.1	EPA	Ammonia, Nitrogen (Automated phenate)
Non-potable Water	Spectrophotometric	Nitrogen Series	350.2	EPA	Ammonia, Nitrogen (w. distillation)
Non-potable Water	Spectrophotometric	General Chemistry	3500-CR D	SM	Chromium (Hexavalent)
Non-potable Water	Spectrophotometric	Metals	3500-FE D	SM	Ferrous Iron
Non-potable Water	Spectrophotometric	Nitrogen Series	351.2	EPA	Nitrogen, Total Kjeldahl (TKN)
Non-potable Water	Spectrophotometric	Nitrogen Series	351.2	EPA	Nitrogen, Total Organic (TON), automated
Non-potable Water	General Chemistry	Nitrogen series	351.2-350.1	EPA	Organic Nitrogen (calculation)
Solid & Hazardous Waste	Extraction	Organics	3510C	SW-846	Separatory Funnel Liquid-Liquid
Solid & Hazardous Waste	Extraction	Organics	3520C	SW-846	Continuous Liquid-Liquid
Non-potable Water	Spectrophotometric	Nitrogen Series	353.2	EPA	Nitrate/Nitrite, Automated Cd Reduction

Non-potable Water	Spectrophotometric	Nitrogen Series	353.2	EPA	Nitrite-Nitrogen, Automated Cd Reduction
Non-potable Water	Spectrophotometric	Nutrients	353.2	EPA	Nitrate-Nitrogen, Automated Cd Reduction
Drinking Water	Spectrophotometric	Nutrients	353.2	EPA	Nitrate-Nitrogen
Drinking Water	Spectrophotometric	Nitrogen Series	353.2	EPA	Nitrite-Nitrogen
Drinking Water	Spectrophotometric	Nitrogen Series	353.2	EPA	Nitrate/Nitrite
Non-potable Water	Spectrophotometric	Nitrogen Series	354.1	EPA	Nitrite-Nitrogen
Solid & Hazardous Waste	Extraction	Organics	3541	SW-846	Soxhlet (Automated)
Solid & Hazardous Waste	Extraction	Organics	3550B	SW-846	Ultrasonic Extraction
Solid & Hazardous Waste	Extraction	Organics	3580A	SW-846	Waste Dilution
Non-potable Water	Potentiometric	General Chemistry	360.1	EPA	Oxygen, Dissolved
Solid & Hazardous Waste	Clean-Up	Organics	3610B	SW-846	Alumina Cleanup
Solid & Hazardous Waste	Clean-Up	Organics	3620B	SW-846	Florisil Cleanup
Solid & Hazardous Waste	Clean-Up	Organics	3640A	SW-846	Gel-Permeation Cleanup
Non-potable Water	Spectrophotometric	Nutrients	365.2	EPA	Phosphate (Ortho)
Non-potable Water	Spectrophotometric	Nutrients	365.2	EPA	Phosphorus (Total), Persulfate digestion
Solid & Hazardous Waste	Clean-Up	Organics	3660B	SW-846	Sulfur Cleanup
Solid & Hazardous Waste	Clean-Up	Organics	3665A	SW-846	Sulfuric Acid/Permanganate Cleanup
Non-potable Water	Titrimetric	Sulfide Species	376.1	EPA	Sulfide, as S
Non-potable Water	Potentiometric	Demand Series	405.1	EPA	BOD5
Non-potable Water	Spectrophotometric	Demand Series	410.4	EPA	COD, Automated
Non-potable Water	Gravimetric	Hydrocarbons	413.1	EPA	Oil & Grease
Non-potable Water	Infrared Spectrophotometric	Carbon	415.1	EPA	Total Organic Carbon (TOC)
Non-potable Water	Infrared Spectrophotometric	Carbon	415.1	EPA	Dissolved Organic Carbon
Non-potable Water	Gravimetric	Hydrocarbons	418.1	EPA	Petroleum Hydrocarbons-IR (TPHC)
Non-potable Water	Spectrophotometric	Phenols	420.2	EPA	Phenols, Total (Automated)
Drinking Water	General Chemistry	General Chemistry	4500-Cl D, E, F, G, I	SM	Chlorine, Total
Drinking Water	General Chemistry	General Chemistry	4500-Cl G	SM	Chlorine Residual
Non-potable Water	General Chemistry	General Chemistry	4500-Cl G	SM	Chlorine Residual
Drinking Water	Spectrophotometric	Cyanides	4500-CN C E	SM	Cyanide, Total
Drinking Water	Colorimetric	General Chemistry	4500-CN E	SM	Cyanide, Total
Non-potable	Spectrophotometric	Cyanides	4500-CN G	SM	Cyanide, Amenable to Chlorination

Water					
Drinking Water	Spectrophotometric	Cyanides	4500-CN G	SM	Cyanide, Amenable to Chlorination
Non-potable Water	Spectrophotometric	Cyanides	4500-CN I	SM	Cyanide, Weak & Dissociable
Non-potable Water	Spectrophotometric	Cyanides	4500-CN I	SM	Cyanide, Free (Weak Acid Dissociable)
Non-potable Water	Electrometric	General Chemistry	4500-H+B	SM	pH
Drinking Water	Electrometric	General Chemistry	4500-H+B	SM	pH
Non-potable Water	Potentiometric	General Chemistry	4500-O G	SM	Oxygen, Dissolved
Solid & Hazardous Waste	Purge and Trap	Volatile Organics	5030B	SW-846	Purge and Trap for Aqueous Samples
Solid & Hazardous Waste	Purge and Trap	Volatile Organics	5035	SW-846	Closed System Purge and Trap for Soils and Waste
Drinking Water	GC/MS	Volatile Organics	524.2	EPA	Volatiles, Drinking Water
Drinking Water	GC/MS	Volatile Organics	524.2	EPA	Tentatively Identified Compounds (TICs)
Solid & Hazardous Waste	ICP	Metals	6010B	SW-846	Metals
Non-potable Water	GC/ECD	Pesticides	608	EPA	Organochlorine Pesticides
Non-potable Water	GC/ECD	Pesticides	608.1	EPA	Organochlorine Pesticides
Non-potable Water	GC/ECD	Pesticides	614	EPA	OP Pesticides
Non-potable Water	GC/MS	Volatile Organics	624	EPA	Volatiles
Non-potable Water	GC/MS	Semivolatile Organics	625	EPA	Polynuclear Aromatic Hydrocarbons (PAHs)
Non-potable Water	GC/MS	Semivolatile Organics	625	EPA	Semivolatiles
Solid & Hazardous Waste	Colorimetric	Metals	7196A	SW-846	Chromium (Hexavalent)
Solid & Hazardous Waste	CVAA	Metals	7470A	SW-846	Mercury in Liquid Waste
Solid & Hazardous Waste	CVAA	Metals	7471A	SW-846	Mercury in Solid or Semisolid Waste
Solid & Hazardous Waste	GC/FID	Hydrocarbons	8015B	SW-846	Diesel Range Organics
Solid & Hazardous Waste	GC/FID Direct Aqueous Injection	Volatile Organics	8015B	SW-846	VOC-DAI-Direct Aqueous Injection
Solid & Hazardous Waste	GC/ECD	Pesticides	8081A	SW-846	Organochlorine Pesticides
Solid & Hazardous Waste	GC/ECD	PCBs	8082	SW-846	PCBs
Solid & Hazardous Waste	GC/NPD	Pesticides	8141A	SW-846	Organophosphorous Pesticides
Solid & Hazardous Waste	GC/MS	Volatile Organics	8260B	SW-846	Volatile Organic Compounds
Solid & Hazardous	GC/MS	Semivolatile Organics	8270C	SW-846	PAHs GC/MS Scan Low Level

Waste					
Solid & Hazardous Waste	GC/MS	Semivolatile Organics	8270C	SW-846	Semivolatiles
Solid & Hazardous Waste	GC/MS	Semivolatile Organics	8270C SIM	SW-846	PAHs GC/MS SIM Low Level
Solid & Hazardous Waste	Spectrophotometric	Cyanides	9012A	SW-846	Cyanide, Amenable to Chlorination
Solid & Hazardous Waste	Spectrophotometric	Cyanides	9012A	SW-846	Cyanide, Total
Solid & Hazardous Waste	Titrimetric	Sulfide Species	9034	SW-846	Sulfide, Acid Insoluble
Solid & Hazardous Waste	Electrometric	General Chemistry	9040B	SW-846	Corrosivity, as pH
Solid & Hazardous Waste	Electrometric	General Chemistry	9045C	SW-846	pH, Solid & Waste
Solid & Hazardous Waste	Ion Chromatography	Nutrients	9056	SW-846	Nitrate-Nitrogen
Solid & Hazardous Waste	Ion Chromatography	Anions	9056	SW-846	Nitrite-Nitrogen
Solid & Hazardous Waste	Ion Chromatography	Anions	9056	SW-846	Chloride
Solid & Hazardous Waste	Ion Chromatography	Anions	9056	SW-846	Phosphate [Ortho]
Solid & Hazardous Waste	Ion Chromatography	Nutrients	9056	SW-846	Nitrate/Nitrite
Solid & Hazardous Waste	Ion Chromatography	Anions	9056	SW-846	Bromide
Solid & Hazardous Waste	Ion Chromatography	Anions	9056	SW-846	Fl Fluoride (IC)
Solid & Hazardous Waste	Ion Chromatography	Anions	9056	SW-846	Anions
Solid & Hazardous Waste	Ion Chromatography	Anions	9056	SW-846	Sulfate, as SO4
Solid & Hazardous Waste	Infrared Spectrophotometric	Carbon	9060	SW-846	Total Organic Carbon (TOC)
Solid & Hazardous Waste	Colorimetric	Phenols	9066	SW-846	Phenols, Total
Solid & Hazardous Waste	General Chemistry	Physical Properties	9095A	SW-846	Paint Filter Test
Solid & Hazardous Waste	Waste Characterization	Waste Characterization	Chapter 7, Ignitability	SW-846	Ignitability
CLP	Digestion	Metals	CLP Metals Digestion	ILM04.0	CLP Metals Digestion
Other	General Chemistry	Leach	D-3987	ASTM	ASTM Leaching Procedure
Non-potable Water	Titrimetric	Carbon	Lloyd Kahn	Region II	Total Organic Carbon (TOC)

Clean Air	GC/MS	Semivolatile Organics	Mod TO-13A	EPA	Polynuclear Aromatic Hydrocarbons (PAHs)
CLP	GC/ECD	Pesticides/PCBs	Pesticides / Aroclors	CLP OLM03.2	Organochlorine Pesticides / PCBs
CLP	GC/ECD	Pesticides/PCBs	Pesticides / Aroclors	CLP OLM04.1	Organochlorine Pesticides / PCBs
CLP	GC/ECD	Pesticides/PCBs	Pesticides / Aroclors	CLP OLM04.2	Organochlorine Pesticides / PCBs
CLP	GC/MS	Semivolatile Organics	Semivolatile Organics	CLP OLC02.1	Semivolatiles, Low Level
CLP	GC/MS	Semivolatile Organics	Semivolatile Organics	CLP OLM04.1	Semivolatiles
CLP	GC/MS	Semivolatile Organics	Semivolatile Organics	CLP OLM04.2	Semivolatiles
CLP	GC/MS	Semivolatile Organics	Semivolatile Organics	CLP OLM03.2	Semivolatiles
Solid & Hazardous Waste	Waste Characterization	Waste Characterization	SW846,Chapter7	SW-846	Sulfide (Reactive)
Solid & Hazardous Waste	Waste Characterization	Waste Characterization	SW846,Chapter7	SW-846	Cyanide (Reactive)
Clean Air	GC/MS	Semivolatile Organics	TO-13	EPA	Polyaromatic Hydrocarbons by GC/MS
Clean Air	GC/ECD	Pesticides	TO-4	EPA	Pesticide by GC
Non-potable Water	Calculation	General Chemistry	Total Cr - Cr+6	SM	Chromium, Trivalent by Difference
CLP	GC/MS	Volatile Organics	Volatile Organics	CLP OLM03.2	Volatiles
CLP	GC/MS	Volatile Organics	Volatile Organics	CLP OLM04.1	Volatiles
CLP	GC/MS	Volatile Organics	Volatile Organics	CLP OLM04.2	Volatiles
CLP	GC/MS	Volatile Organics	Volatile Organics	CLP OLC02.1	Volatiles, Low Level

Submit Query



GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

Pre-Design Investigation Work Plan

Cutoff Wall Interim Remedial Measure Greenpoint Energy Center

Brooklyn, New York
Site No. 224052

Submitted to:
National Grid
287 Maspeth Avenue
Brooklyn, NY 11201

Submitted by:
GEI Consultants, Inc.
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January 9, 2009

Project No.: 081200



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1 Existing Monitoring Well Summary

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Appendices

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Abbreviations and Acronyms

ASTM	American Society for Testing and Materials
CPT	Cone Penetrometer Test
DER-10	NYSDEC Draft DER-10 Technical Guidance for Site Investigation and Remediation
DNAPL	Dense Non-Aqueous Phase Liquid
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
ft	Foot or feet
ft bgs	Feet below ground surface
GEI	GEI Consultants, Inc.
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IRM	Interim Remedial Action
IWP	Investigation Work Plan
LNAPL	Light non-aqueous phase liquid
MGP	Manufactured Gas Plant
MS	Microsoft
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAPL	Non-aqueous Phase Liquid
NAD 83	North American Datum 1983
NAVD 88	North American Vertical Datum 1988
NYSDEC	New York State Department of Environmental Conservation
OM&M	Operation Monitoring Maintenance Plan
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance and Quality Control
RAWP	Remedial Action Work Plan
RI	Remedial Investigation
SPT	Standard Penetration Test
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
USDOT	United Sates Department of Transportation
VOC	Volatile Organic Compound

1. Introduction

On behalf of National Grid, GEI Consultants Inc. (GEI) has prepared this Pre-Design Investigation Work Plan (IWP) in support of the development of a Cutoff Wall Interim Remedial Measure (IRM) at the Greenpoint Energy Center at 287 Maspeth Avenue, Brooklyn, New York (**Figure 1**). This investigation is a component of a Remedial Investigation (RI) to be performed in accordance with the requirements set forth in the Consent Order administrated by the New York State Department of Environmental Conservation (NYSDEC). Other components of the RI will be addressed under separate cover. Upon completion of this and subsequent investigations, data findings and evaluation reports will be prepared and submitted to the NYSDEC for review. At the completion of all components of the full RI characterizing the former MGP facility, a comprehensive RI Report will be prepared incorporating the findings from all investigation tasks performed at the site.

The intent of the cutoff wall is to mitigate the potential movement of former manufactured gas plant (MGP) related non-aqueous phase liquid (NAPL) off site and into Newtown Creek and English Kills. For conceptual planning purposes, the proposed wall is assumed to consist of a 2,000 linear foot segment along Newtown Creek, and a 500 linear foot segment along Maspeth Avenue. Actual design dimensions and alignment will be based on the Pre-Design Investigation findings and presented for approval to the NYSDEC in a Remedial Action Work Plan (RAWP). This IWP is the first step in the development of a cutoff wall design, which will be summarized in an Investigation Finding Report. The design program will include the following efforts:

- Implementation of field investigations to gather geotechnical, hydrogeologic and environmental data
- Groundwater modeling and stormwater runoff analysis to define the effects of the proposed cutoff wall on the groundwater regime
- Summation of findings in an Investigation Findings Report
- The cutoff wall design defining alignment, depth and materials of construction
- A RAWP presenting the design for approval to the NYSDEC.

The IWP was developed to focus on details related to cutoff wall design, including NAPL assessment. Analytical sampling for contaminants of concern, although not required for design, will be performed at Pre-Design Investigation locations, to support the RI.

The alignment and depth of the wall will be a function of the NAPL depth encountered along the anticipated cutoff wall, from data obtained through hydrogeologic investigations, and as defined by the hydrogeologic model. Further delineation of subsurface contamination on site is not part of the Pre-Design Investigation.

The remainder of this document is divided into the following sections:

2. **Pre-Design Investigation Work Plan:** defining tasks to be completed in the development of design data and gathering of data for RI purposes.
3. **Cutoff Wall Design:** detailing the components of the design documents.
4. **Schedule:** detailing major milestones within the investigation and design program. A Microsoft (MS) project Gantt timeline of the investigation and design is included in Appendix A.

An electronic version of the approved site-specific Health and Safety Plan (HASP) is included in Appendix B. The HASP is broad in nature and is intended for use in future field investigations at the site in addition to this IWP field activities.

An electronic version of the approved Field Sampling Plan (FSP) detailing soil and sediment sampling, monitoring well installation, development and sampling, test pit excavation and sampling, equipment decontamination, and investigation derived waste handling (IDW) procedures is included in Appendix C.

An electronic version of the approved site specific Quality Assurance Project Plan (QAPP) is included in Appendix D. The QAPP has been developed to address quality control/quality assurance (QA/QC) issues and ensure the integrity of analytical data obtained during all investigations.

2. Pre-Design Investigation Work Plan

This IWP identifies proposed investigation locations, geotechnical and hydrogeologic investigation approaches and procedures, site surveys, and defines the hydrogeologic modeling approach. Test pit and geophysical assessments may also be included to help define the method of cutoff wall construction, condition of the bulkhead infrastructure, and to identify other subsurface structures of concern. The IWP includes an existing conditions assessment (subsection 2.1), subsurface investigation and laboratory testing (subsection 2.2) and hydrogeologic modeling (subsection 2.3).

The investigation will provide geotechnical, hydrogeologic, and environmental data, an assessment of existing conditions and wall conflicts, and delineation of the vertical and horizontal extent of NAPL along the proposed wall alignment. Review of available site subsurface data, including previous geotechnical and environmental subsurface investigations, bulkhead design documents, utility drawings, and related documents available from agency postings has been performed. However, due to the relative size and history of the site, the availability of additional relevant site records and documentation will require further research. New information may be used to refine parts of this work plan as it becomes available. Specifically, information relating to the historical MGP plant infrastructure footprint and current/former stormwater management systems is being sought for inclusion in the hydrogeologic model of the site.

The cutoff wall design will be partially based on predicted hydraulic performance. Because the proposed wall will cut off groundwater flow, the design may include a groundwater extraction system upgradient of the wall. A hydrogeologic study is proposed to measure groundwater flow gradients, water level elevations, influence of utilities and stormwater infiltration, and tidal influence that may affect or be affected by the cutoff wall. The hydrogeologic study will support a groundwater model for remedial design.

The hydrogeologic study is designed to identify groundwater flow patterns that may influence or be influenced by the proposed cutoff wall. Currently, groundwater flow may be influenced by several conditions that will be investigated under this IWP. The groundwater flow system is likely influenced by many factors as outlined herein. A preliminary review of available groundwater elevations coupled with the proximity of the site to tidal waters and historical marsh indicate that the groundwater table is relatively flat. The former Newtown Creek shoreline was several hundred feet inland to the west of the present-day Newtown Creek, with Mussel Island offshore to the east (**Figure 2**). The historic fill in this area may affect groundwater flow patterns. Pre-MGP topography suggests that shallow groundwater may converge toward the former channel, or along the former Newtown Creek wetlands

complex to the east. There may be a component of flow toward the English Kills, southeasterly from higher ground north and west of the former MGP. Storm drainage systems and process piping may create preferential pathways for shallow groundwater movement and recharge. A low-permeability meadow mat (former wetland surface) and clay layer beneath fill in some locations may serve as a confining unit. Deeper groundwater flow direction may have a westerly or northerly component, due to expected westerly regional flow off Long Island toward the East River, or potential northerly flow along the course of Newtown Creek.

A total of 16 monitoring wells from previous investigations are known to exist on site and appear to be functional (**Table 1**). The existing wells are located in three groupings:

- West of the former MGP, five wells (MW-2 through MW-5, and an unnamed well);
- North of the former MGP, four shallow/deep pairs (MW-1S/D through MW-4S/D); and
- Southeast of the former MGP along Maspeth Avenue, three wells (W-1 through W-3).

The northern well grouping was installed during an IRM investigation completed in March 2005. Installation details for the other two well groupings were not available. Five other wells reportedly existed on site, but could not be found during the June 2008 gauging (MW-5S/D in the northeast grouping, W-4 and GPW-7 along Maspeth Avenue, and MW-1 in the northwest grouping).

GEI gauged the existing wells on June 16, 2008. The measurements indicate a relatively flat gradient; however, an accurate survey is needed to determine groundwater flow direction. A slight downward gradient was observed in the northern well grouping, where well pairs were screened above and below low-permeability soil. However, because the measurements represent one-time readings, additional study is needed to assess the average gradient relative to tide cycles. Due to the limited data available from the existing wells, additional study of the groundwater gradient will be required before a final selection is made on the location of new monitoring wells. This effort is addressed as Task 2 of the subsurface investigation as discussed in subsection 2.2.

2.1 Existing Conditions Assessment

2.1.1 Site Property Survey

A property survey will be performed along the alignment of the proposed cutoff wall to provide a base plan for the design drawings and establish existing conditions and elevations. The survey will consist of a topographic survey, a boundary survey, and a surface and subsurface survey of existing utilities along the alignment. Aerial photography will likely be used to provide the base for the topographic survey with supplemental field locations

obtained in obscured areas. A boundary survey will be performed to locate property lines and corners along the cutoff wall alignment. All locations and elevations will be referenced to the New York State Plane Eastern Zone (3104) North American Datum 1983 (NAD83) and North American Vertical Datum (NAVD 88). An easements search will be performed as part of the utility survey. Available historical infrastructure records including on-site and adjacent historical utility records will be reviewed. This will include a review of plans from local private utility companies, National Grid, and Borough municipal utilities (water, sewer, etc.) as well as applicable county and/or state records. After the records review is complete, a utility markout will be called into the New York City One Call Center. The identified utilities and manhole invert elevations (where accessible) will then be surveyed and documented on the base site map. The existing explorations and historical data will be overlaid as needed. If needed, historical subsurface structures along the proposed wall alignment will be field demarcated based upon the historical plans and records and related to common features that are currently on the site. Following this mark out, test pits may be excavated to verify the presence and locations of the historical features to determine the potential degree of interference with construction of the proposed wall. Because of the size and complex history of the site, not all the site utilities, such as minor branches and connections, will be surveyed.

2.1.2 Utility Geophysical Survey

A utility documentation and geophysical survey may be appropriate to identify investigation and construction subsurface conflicts with existing utilities and structures that could not be validated under the utility markout effort noted above, or requiring more precise delineation due to potential conflicts with the proposed cutoff wall. The utilities would be located on site using ground penetrating radar and electro-magnetic pipe, cable and box locators. Once the utilities are located, the horizontal and vertical location of each utility will be surveyed and documented on the site basemap.

2.1.3 Stormwater System Evaluation

A document review and site reconnaissance will be performed to assess locations of current and possible historical subsurface drainage features that may affect the groundwater flow direction and serve as potential preferential flow conduits. This information will also be used for drainage design calculations and associated permitting for the cutoff wall. Topography, drainage utilities, and former production piping will be mapped to confirm or refine monitoring well locations. Ground cover type and topographic low points will be mapped to identify potential surficial influences on the water table. Geophysics and confirmation of historical features through test pits, may be necessary to confirm the location, depth, and interconnectedness of historical drainage systems.

2.2 Subsurface Investigations and Laboratory Testing

Field investigations will be conducted to acquire hydrogeologic, geotechnical, and environmental data. An aquifer pumping test will also be performed to acquire aquifer yield data and to assess the potential presence of hydrogeologic boundary conditions related to the heterogeneity of the former creek channel, wetland complex, and historical infrastructure beneath the site. These data will be necessary to adequately estimate the potential volume of groundwater collection and/or treatment related to installation of the proposed containment wall. The field investigation will consist of two tasks:

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- Task 1 (Hydrogeologic Study) will consist of an initial groundwater elevation survey of existing wells, installing new monitoring wells located to define potential flow gradients, NAPL assessment, stormwater evaluation, and an aquifer pumping test.
- Task 2 (Geotechnical Study) will consist of cone penetrometer and/or conventional borings, geotechnical laboratory testing, and if necessary, piezometer installation and test pit excavations.

Both tasks will include analytical chemical testing for contaminants of concern in associated borings and monitoring wells, in support of the RI. Figure 2 shows approximate proposed boring and well locations, subject to change based on initial findings and accessibility. Supplemental locations will be determined based on preliminary findings.

2.2.1 Task 1 - Hydrogeologic Study

An attempt will be made to verify the existence of unfound wells. The condition of the existing wells will be evaluated and the wells will be redeveloped if necessary. In the event well construction details and/or associated boring logs are not available, a video survey of existing wells will be performed to identify screen depth intervals, and borings may be advanced during subsequent phases adjacent to existing well clusters to assess the localized geologic setting. The existing wells and a tidal gauging point will be surveyed by a licensed surveyor relative to the datum established under subsection 2.1. Groundwater elevations will be measured at existing wells to form a preliminary groundwater contour map. Gauging for the presence of NAPL will be performed at all monitoring well locations. Tidal fluctuations will be measured in select monitoring wells and in Newtown Creek.

To gather hydrogeologic data for the groundwater model, installation of monitoring wells at 13 locations is proposed (**Figure 2**). The five monitoring well borings closest to Newtown Creek will be extended to a minimum of 100 feet below ground surface (ft bgs) and at least 10-feet below the deepest MGP-related contaminant observed in the borehole, based on field screening described in the FSP. The remainder of the monitoring wells will be advanced to a minimum of 50 ft bgs, and at least 10-feet below the deepest MGP-related contaminant observed in the borehole. Upon completion of the soil borings, monitoring wells will be

installed to depths appropriate to gather hydrogeologic data as detailed below and the remainder of the boring will be tremie grouted to depth using a cement/bentonite slurry mixture. Following installation, groundwater elevations will be measured at all monitoring wells. Aquifer parameter tests will be performed including slug tests, infiltration tests, and aquifer pumping tests. The aquifer testing is described below in subsection 2.2.2.4.

Note that the five monitoring well borings to be advanced to a minimum of 100 ft below ground surface are located inboard of the bulkhead-dock structure along the creek. The structure consists of a pile-supported timber dock 40-feet wide capped with about 7-feet of soil fill. Rip-rap has been placed along the inboard edge of the dock, which slopes inland below grade, potentially an additional 25-feet. Therefore, the borings are proposed to be set approximately 65-feet inboard of the bulkhead face to be in historic fill and natural formation along the creek shoreline. The proposed placement of the borings 65-feet inboard of the bulkhead is considered as close to the shoreline as practical to obtain relevant subsurface data. Existing utilities and operational features will also affect the final location of these and other bulkhead-dock structure borings.

The monitoring wells installed just inboard of the bulkhead-dock structure are to identify flow patterns relative to the former Newtown Creek, and English Kills to the south, the wells in central and western portions of the site are to further define hydraulic gradients, establish model boundary conditions, and assess potential off-site influences. Actual locations may be modified based on interim findings as the field effort and document review progresses. One water table monitoring well is planned at each location, and intermediate zone monitoring wells will be installed at approximately half of the locations, to define conditions related to potential confining layers. Supplemental monitoring wells will be installed to investigate areas of concern based on initial findings.

Shallow monitoring wells will be screened as water table wells above the meadow mat (if present). Nominally, intermediate monitoring wells will be screened below the meadow mat or other potential confining lenses, to define vertical gradients and variation in flow direction with depth. Care will be taken to evaluate the site stratigraphy and prevent dense non-aqueous phase liquid (DNAPL) migration below apparent confining layers. Deeper monitoring wells will be placed in the same or apparent similar hydrostratigraphic zones as suggested by the presence and elevation of possible semi-confining layers. Monitoring wells will be developed in accordance with the FSP.

Soil samples will be collected and logged continuously from each boring location in accordance with the FSP. Deep drilling through impacted zones will use telescoped casing to ensure that there is no vertical migration of DNAPL caused by the drilling. Specifically, the upper potentially-impacted units would be cased and sealed into a lower, more confining unit. Drilling methods and procedures are described in the FSP.

The locations and elevations of the new monitoring wells and borings will be surveyed. Two rounds of groundwater elevation readings will be taken at all monitoring wells, each round at both high and low tide. A full tidal study will be performed, consisting of 24-hour water level monitoring at select wells and tidal elevations in Newtown Creek using dataloggers. Rising head slug tests will be performed at all monitoring wells adjacent to Newtown Creek and at select upland locations to assess the hydraulic conductivity at each monitoring well location. Further details of field procedures are presented in the attached FSP.

Drilling equipment (i.e., drilling rods, auger, casing, and/or macro-core sampler) will be decontaminated between each sample location. Soil cuttings and decontamination fluids will be collected in 55-gallon United States Department of Transportation (USDOT) drums, lined roll-off dumpster or fractionation tank and will be disposed of by National Grid following characterization.

2.2.1.1 Laboratory Chemical Testing

To support RI characterization efforts, soil and groundwater samples collected during the investigation will be tested for chemical contaminants potentially associated with the former MGP operations, other historical operations, and for treatment and waste characterization purposes. Samples will be analyzed by a New York State Environmental Laboratory Accreditation Program (ELAP)-certified laboratory.

Up to three soil or sediment samples per boring will be selected for chemical analysis as follows.

- The depth interval indicating the greatest apparent degree of contamination within 5 feet of ground surface, to characterize the utility depth interval.
- The depth interval indicating the greatest degree of impacts over the depth of the boring.
- For intermediate zone monitoring well locations, a sample will be collected at the depth of the center of the well screen.
- The boring termination depth.
- If no evidence of contamination is observed, then a sample will be collected from the depth of the observed groundwater table.

Soil or sediment samples will be collected over approximate 2-foot depth intervals. The greatest degree of contamination will be identified by photoionization detector (PID) screening and by visual and olfactory observations. Field screening procedures are described in the FSP.

Each soil or sediment sample will be analyzed for:

- Volatile organic compounds (VOCs) by the United States Environmental Protection Agency (EPA) SW-846 method 8260B
- Semivolatile organic compounds (SVOCs) by EPA method 8270C
- Target Analyte List (TAL) metals by EPA method 6000/ 7000 series;
- Polychlorinated biphenyls (PCBs) by EPA method 8082.
- Free cyanide extraction by EPA method 9013A and analysis by Microdiffusion, American Society for Testing and Materials (ASTM) method D4282-02.
- Hexavalent chromium by EPA method 3060A/7196
- Total organic carbon by EPA method 9060 (select samples)

Monitoring wells will be sampled for site contaminants of concern. Monitoring wells will be purged and sampled in accordance with the FSP. All monitoring wells will be sampled, with the exception of closely-spaced wells installed for monitoring groundwater fluctuations around utilities and for pumping testing (described further below in subsections 2.2.2.3 and 2.2.2.4). For closely-spaced well clusters, one shallow and one deep well within each cluster will be selected for sampling. Each groundwater sample will be analyzed for:

- VOCs by EPA method 8260B
- SVOCs by EPA method 8270C
- TAL metals by EPA method 6000/7000 series
- PCBs by EPA method 8082
- Total cyanide by EPA Method 9012B
- Free cyanide extraction by EPA method 9013B and analysis by Microdiffusion, ASTM method D4282-02
- Hexavalent chromium by EPA method 7196

If DNAPL accumulation is present in any well, no groundwater sample will be collected for laboratory analysis.

QA/QC procedures are detailed within the QAPP (Appendix D). QA/QC samples will include blind duplicate soil or sediment samples, Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples, and equipment rinsate blank samples. The quality control samples will be completed on a frequency of 1/20 per matrix. An approved ELAP laboratory will perform the analyses. One trip blank will be included per shipment of samples to the laboratory.

2.2.1.2 NAPL Assessment

A NAPL [either DNAPL tar, or light non-aqueous phase liquid (LNAPL) hydrocarbons] assessment will be performed to evaluate the distribution, potential recoverability, physical and chemical characteristics of the material. All wells potentially containing NAPL based on boring observations will be gauged using an oil/water interface probe. If measurable NAPL is observed, then the NAPL will be bailed or pumped from the well and the volume of bailed material will be recorded. All NAPL removed from a well will be containerized for disposal. The recovery rate of the NAPL will be assessed through periodic measurements with an oil/water interface probe. Recovered NAPL will be examined and described by the field representative. If present, up to three samples of DNAPL tar will be collected and analyzed for waste characterization purposes, and to determine the density and viscosity of the DNAPL.

2.2.1.3 Stormwater Evaluation

A stormwater evaluation is proposed to:

- Assess the affect of potential preferential groundwater flow pathways along major utility corridors.
- Assess the affect of buried structures and impervious areas on groundwater flow sitewide.

Groundwater flow may be influenced locally by buried conduits, concrete foundations, and ponding at topographic low points. In addition, former stream channels and backfill around storm sewers may serve as preferential groundwater flow pathways. A study is proposed to investigate potential preferential flow pathways along Maspeth Avenue and along the central utility corridor for the former MGP process area (along the Stores Building and Service Building, Figure 2). The Maspeth Avenue corridor was chosen because it contains a 48-inch-diameter drain, which is the largest known drain at the site and, therefore, has the greater potential to result in measureable effects. The central utility corridor for the former plant (along the Stores Building and Service Building) contains two 36-inch drains and a variety of other utilities, which collectively have a higher potential to measurably affect groundwater flow.

A series of monitoring wells will be installed adjacent to and at specified distances from the utility corridors. Piezometers are proposed within or adjacent to the utility corridors, and at 50 and 125 feet from (perpendicular to) the utility corridor to assess drawdown or mounding approaching the corridors (Figure 2). Actual piezometer distances may vary depending on accessibility and soil type. Control locations will be selected further from the potential influences. Water level elevations will be logged electronically up to a 60 day period to capture storm events, tidal and barometric pressure affects, and associated fluctuations caused by potential leakage into or out of the drains.

Sitewide, if at any point in the pre-design investigation the potential for significant localized influences on the water table is identified, such as mounding due to water retention in pervious areas or buried structures, further infiltration studies may be performed.

Soil and groundwater samples may be collected from the infiltration study borings and monitoring wells at National Grid's discretion.

2.2.1.4 Aquifer Testing

Aquifer testing will be performed to evaluate groundwater response to pumping stress. Available information suggests that the flow boundaries along the former shoreline, anisotropy within the former stream channel, and connectivity between shallow and intermediate groundwater zones may significantly affect flow.

Following installation of the proposed monitoring wells (described earlier in this work plan), assessment of the groundwater contour patterns, and evaluation of potential variability in hydrostratigraphic units across the site, GEI will develop an aquifer pumping test work plan detailing the design of the pumping test, wells to be monitored, and the management, treatment, and disposal methods of extracted groundwater. The pumping test work plan will be submitted to NYSDEC for review and approval prior to start of the pumping test.

As an overview, the proposed pumping test location will be at the edge of the former mud flats adjacent to the former MGP process area, where effects of the mud flat shoreline and abandoned facilities may be observed. Aquifer testing will likely consist of two step-drawdown tests: one pumping from the shallow screened zone, and one from the intermediate zone. Pumping test duration is expected to be of 30-hour, or less, if steady-state drawdown is observed in shorter time. Two temporary pumping wells (shallow and intermediate) and a network of monitoring wells will be installed at the proposed test location (Figure 2). Based on expected soil permeabilities, we propose installing monitoring wells at 10, 20, 40, and 80 feet from the pumping well in two directions, and at shallow and intermediate depth zones. Specific monitoring well locations and screening depths will be specified in the pumping test work plan.

Aquifer testing may require permits related to groundwater withdrawal and recharge or discharge to sewer depending on anticipated volume of water pumped. If a relatively low volume is anticipated, off-site disposal may be adequate.

2.2.2 Task 3 - Geotechnical Investigation

The geotechnical investigation will initially consist of advancement of 22 soil borings to evaluate constructability and design of the cutoff wall. The geotechnical borings will be advanced along the conceptual cutoff wall alignment (Figure 2) using cone penetrometer tests (CPTs) or conventional (hollow-stem auger, rotary, sonic) drilling methods.

Supplemental borings may be advanced along a more specific wall alignment or at closer spacings to be defined based on the initial geotechnical and hydrogeological findings.

The borings will be advanced to a minimum of 50 ft bgs or at least 10-feet below the deepest MGP-related contaminant observed in the borehole, based on field screening described in the FSP, whichever is deeper. Upon completion, the soil borings will be tremie grouted to grade using a cement/bentonite slurry mixture or completed as monitoring wells.

Geotechnical testing will include Standard Penetration Tests (SPT) and split barrel sample collection. Sampling will be performed continuously through fill materials and at 5-foot intervals in native deposits. Soil samples will be logged in accordance with Unified Soil Classification System. If encountered, organic and fine-grained soil will be sampled using a thin-walled sampler. Index tests, consisting of grain-size analyses (including hydrometer analyses), organic content, Atterberg Limits and moisture content, will be performed on representative soil samples. Unconsolidated-undrained triaxial compression tests will be performed on cohesive soil samples.

If conditions permit, cone penetrometer tests (CPTs) maybe substituted for selected boreholes. CPTs can provide a rapid assessment of soil stratigraphy, relative density, strength, and equilibrium groundwater pressures within certain subsurface conditions.

Any deep borings that penetrate tar-impacted zones will be telescoped to prevent vertical communication of DNAPL caused by the drilling. Specifically, the upper potentially-impacted units would be cased and sealed into a lower, more confining unit, if encountered. Drilling methods and procedures will be consistent with the FSP.

Up to three soil samples per boring will be selected for chemical analysis (excluding CPT borings), at the depth intervals and parameters described for the hydrogeologic investigation (Section 2.2.1) except for borings within Newtown Creek. For borings within Newtown Creek, sediment samples may be collected to represent the benthic zone or impacted sediments, in place of the utility corridor depth interval.

Decontamination will be performed as described in the FSP.

Since a portion of the borings will be advanced within Newtown Creek, it is anticipated that a barge mounted drill rig will be necessary. Permits will include Coast Guard, Corps of Engineers, and local law enforcement approval as appropriate.

Test pits may be excavated along the existing bulkhead to confirm the geometry of the existing wall and identify other potentially significant features. The need for test pits will be determined after soil boring and utility data are collected and evaluated. Test pits, if

excavated, will be performed according the FSP. Soil may be sampled for chemical analysis at National Grid's discretion.

2.3 Hydrogeologic Modeling

A three-dimensional model will be developed and calibrated using Visual MODFLOW, a proprietary interface which runs the public-domain MODFLOW code developed by the U.S. Geological Survey. The model will be based on the collected hydraulic head data, site stratigraphy, regional hydrogeologic data, and aquifer test parameters based on the results of the pumping tests and in-situ hydraulic conductivity tests. The proposed wall will be modeled at various depths and locations, with wing walls as needed. Groundwater mounding, and flow around or beneath the wall will be evaluated. For proposed wall layouts that may cause unacceptable mounding or flow around the wall, configuration modification, groundwater control or extraction systems will be modeled.

The model will assess effects of precipitation recharge and conduits found to significantly influence groundwater flow. The proposed model will include saturated groundwater flow only. No transport of dissolved contaminants or NAPL will be simulated in the model.

2.4 Investigation Findings Report

Once the subsurface explorations are complete, an Investigation Findings Report will be prepared. The report will summarize the geotechnical and hydrogeologic data, the available information on existing utility locations, topographic and boundary survey, analytical soil, sediment, and groundwater data, and other data collected during the pre-design activities. The report will describe the subsurface explorations and soil sampling methods used, summarize the geotechnical laboratory testing data collected, summarize the NAPL location data collected, include an exploration location plan, and include interpreted subsurface profiles. The extent of NAPL intended to be addressed by the cutoff wall will be depicted in the report. In addition, the groundwater model baseline calibration and relevant iterations depicting the affects of cutoff wall configurations will be presented in support of the conceptual wall configuration selection.

The report will be used in support of the design effort and will be provided to contractors for preparation of bids and construction. The report will be submitted to the NYSDEC as an informational document. A meeting with the NYSDEC is proposed to present and discuss the findings prior to initiation of wall design activities. Information within the report in conjunction with additional site investigations will be submitted to the NYSDEC as a Remedial Investigation Report.

3. Cutoff Wall Design

This section presents the approach to the Remedial Action Work Plan for the cutoff wall IRM. The process is divided into two work plan deliverables in general accordance with NYSDEC *Technical Guidance for Site Investigation and Remediation DER-10*. Each work plan is detailed below. A sheet pile cutoff wall is anticipated. However, alternative methods may be required in select locations due to subsurface conditions, obstructions or utilities.

At this point, a field constructability analysis has not been considered. However, this step may be required based on the findings of the IWP.

3.1 Draft Remedial Action Work Plan

The initial design submittal to the NYSDEC will be the Draft RAWP detailing the IRM. This submittal will contain draft versions of the cutoff wall construction approach, wall location and configuration, engineering drawings, and technical specifications. The work plan will include the following components:

- Design criteria of the cutoff wall system
- Movement criteria and geotechnical monitoring requirements
- Groundwater control and treatment
- Noise and vibration criteria and monitoring requirements (as applicable)
- Community air monitoring requirements (as applicable)
- Preliminary Permits Evaluation
- Engineering Plans (preliminary design drawings)
- Technical specifications (preliminary)

Comments from the NYSDEC on the draft work plan will be addressed in the Final RAWP.

3.2 Final Remedial Action Work Plan

The Final RAWP will be prepared after receipt of the NYSDEC comments. After the NYSDEC comments are received, National Grid and GEI will meet with the NYSDEC to discuss our responses to their comments. Once all responses are accepted by the NYSDEC, the Final RAWP will be prepared and submitted to the NYSDEC.

The Final RAWP will include those items noted in the draft submittal as edited plus the additions/modifications that follow:

- Final Engineering Plans and Technical Specifications
- Draft Operation Monitoring Maintenance Plan (OM&M) Plan for ongoing activities to be performed after the completion of the IRM
- Opinion of Cost estimate for construction of the IRM. Since contractor's means and methods may vary from the Engineer's assumption, the cost estimate will vary from the remedial contractor's costs.
- Schedule for completion of the IRM

4. Schedule

A draft schedule detailing the development of the RAWP is presented in Appendix A. The schedule targets a start date for field investigation activities of February 2009.

Table

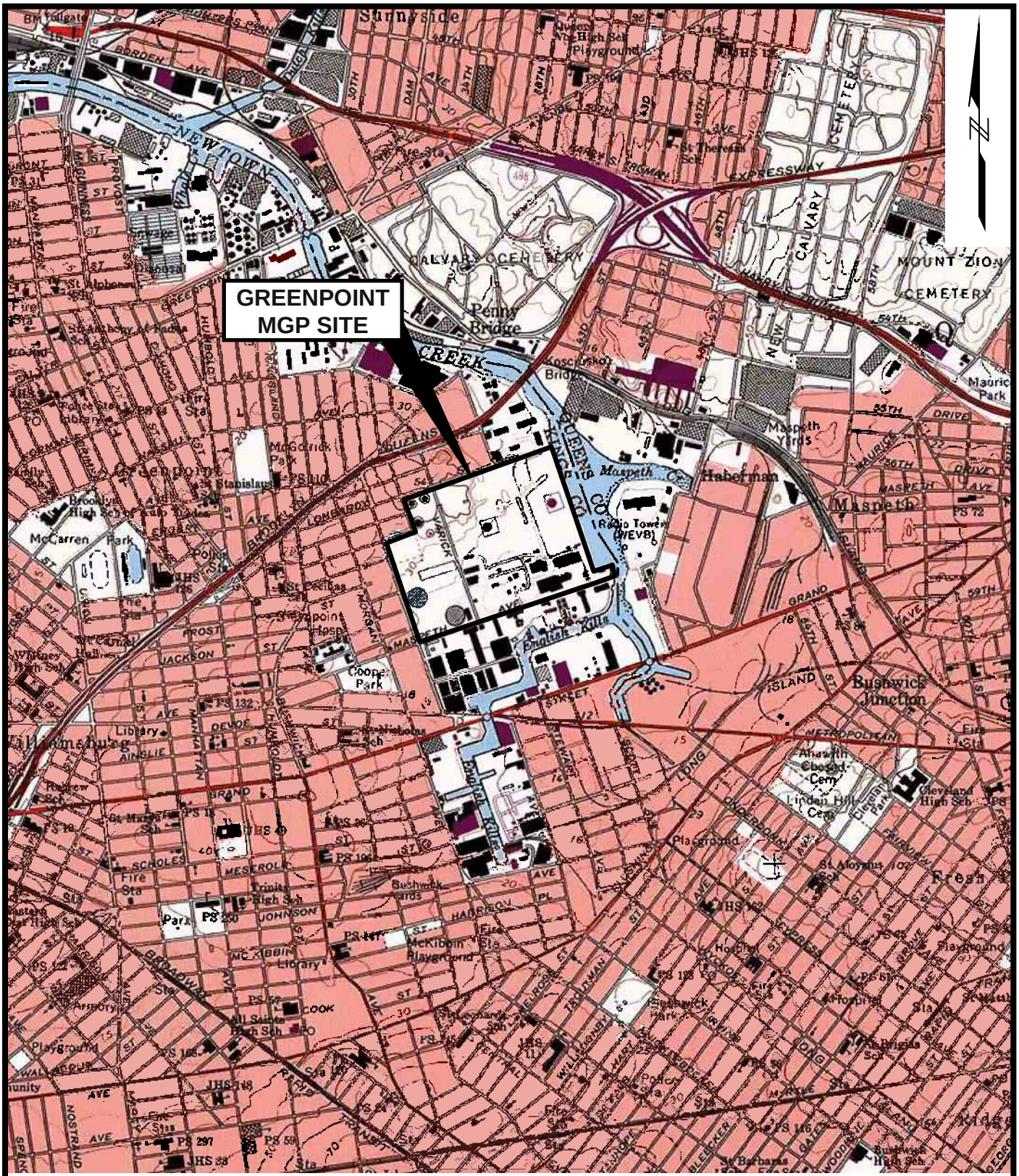
Table 1
Existing Monitoring Well Summary
Greenpoint Energy Center
Brooklyn, New York

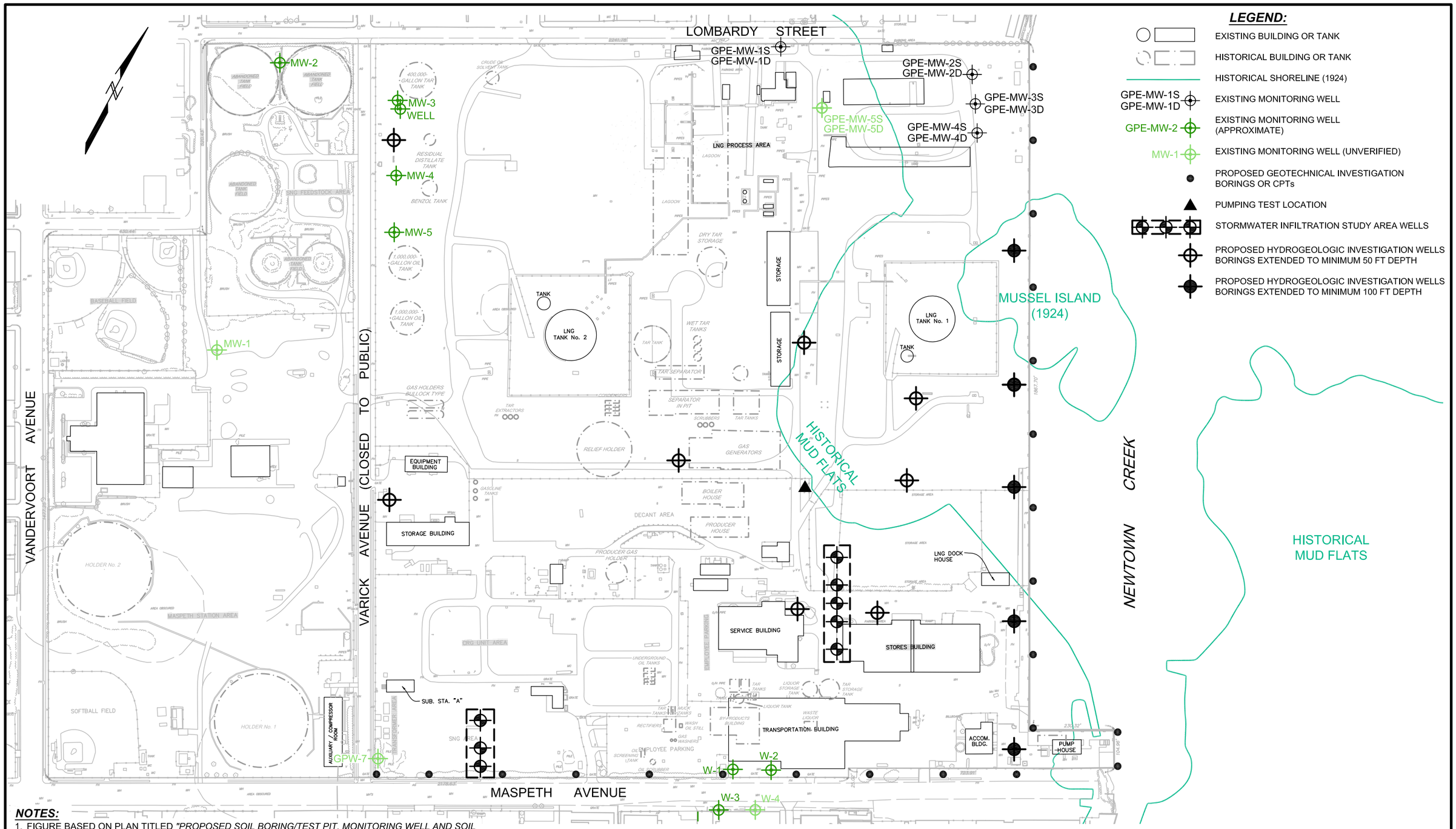
Monitoring Well Name	Well Depth, ft bgs	Screen Length, ft	Associated Boring	Existence Verified[1]
Northeast Corner IRM Well Grouping				
GPE-MW-1S	26	10	GPE-MW-1S/1D	Yes
GPE-MW-1D	55.5	10	GPE-MW-1S/1D	Yes
GPE-MW-2S	12	10	GPE-MW-2S/2D	Yes
GPE-MW-2D	40.5	10	GPE-MW-2S/2D	Yes
GPE-MW-3S	12	10	GPE-MW-3S/3D	Yes
GPE-MW-3D	40	10	GPE-MW-3S/3D	Yes
GPE-MW-4S	12	10	GPE-MW-4S/4D	Yes
GPE-MW-4D	40	10	GPE-MW-4S/4D	Yes
GPE-MW-5S	26	10	GPE-MW-5S/5D	No
GPE-MW-5D	55	10	GPE-MW-5S/5D	No
North Varick Street Well Grouping				
MW-1	Unknown	Unknown	Unknown	No
MW-2	53	Unknown	Unknown	Yes
MW-3	49	Unknown	Unknown	Yes
MW-4	45	Unknown	Unknown	Yes
MW-5	10	Unknown	Unknown	Yes
Well	49	Unknown	Unknown	Yes
Central Maspeth Avenue Well Grouping				
W-1	20	Unknown	Unknown	Yes
W-2	20	Unknown	Unknown	Yes
W-3	18	Unknown	Unknown	Yes
W-4	Unknown	Unknown	Unknown	No
Maspeth/South Varick Well Grouping				
GPW-7	Unknown	Unknown	Unknown	No

Note:
ft bgs - feet below ground surface

[1] Monitoring wells identified during site reconnaissance on June 16th, 2008

Figures


GREENPOINT
MGP SITE
N
Sunnyside
NEWTOWN CREEK
Penny Bridge
CALVARY CEMETERY
MOUNT ZION CEMETERY
Maspeth
Haberman
Bushwick Junction
Bushwick Houses
McCarren Park
Cooper Park
Playground
Greenpoint Hosp.
Brooklyn High School
Trinity High Sch
Cleveland High Sch
Fresh
Maspeth Creek
Maspeth Yards
Radio Towers (WEVD)
Calvary Cem
Mount Zion Cem
Linden Hill Cem
Evergreen Cem
Bushwick Houses
Playground
Playground
Playground



NOTES:

1. FIGURE BASED ON PLAN TITLED *"PROPOSED SOIL BORING/TEST PIT, MONITORING WELL AND SOIL GAS SAMPLE LOCATIONS SITE PLAN,"* BY PAULUS SOKOLOWSKI AND SARTOR ENGINEERING, PC DATED OCT. 2004.
2. HISTORIC SHORELINE FROM *PORT FACILITIES AT PORT OF NEW YORK, NEWTOWN CREEK,* PREPARED BY US ENGINEER OFFICE, FIRST DISTRICT, NEW YORK CITY, DATED JUNE 1924, SCALE: 1" = 100' FEET.
3. PROPOSED BORING/PIEZOMETER LOCATIONS SUBJECT TO CHANGE BASED ON FINDING OF INITIAL GROUNDWATER SURVEY FROM EXISTING WELL (PHASE 1 OF IRM INVESTIGATION).
4. UNVERIFIED WELLS WERE NOT LOCATED DURING GEI SITE RECONNAISSANCE VISIT ON JUNE 16, 2008.

0 250 500

SCALE, FEET

PRE-DESIGN INVESTIGATION WORK PLAN
GREENPOINT ENERGY CENTER
BROOKLYN, NEW YORK

nationalgrid

GEI Consultants

FIELD INVESTIGATION PLAN

Project 081200 | January 2009 | Figure 2

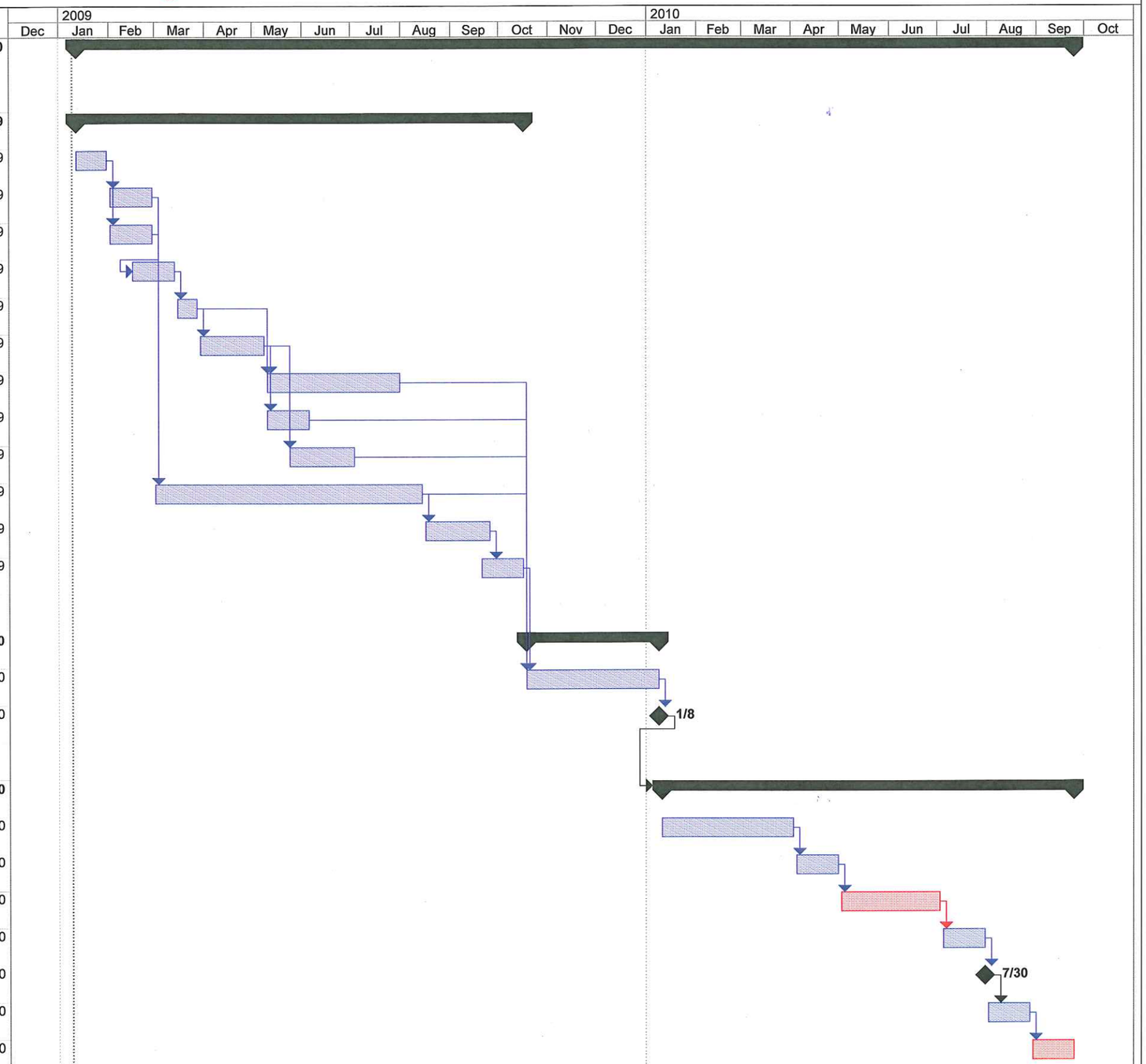
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Appendix A

Schedule

Cutoff Wall Remedial Action Work Plan
Greenpoint Energy Center
Working Schedule

ID	Task Name	Duration	Start	Finish
1	**Program Duration**	**445 days**	**Mon 1/12/09**	**Fri 9/24/10**
2				
3	**Pre-Design Investigation**	**200 days**	**Mon 1/12/09**	**Fri 10/16/09**
4	Mobilization	3 wks	Mon 1/12/09	Fri 1/30/09
5	Existing Well Redevelopment, Survey and Monitoring	4 wks	Mon 2/2/09	Fri 2/27/09
6	Property/Topo Survey	4 wks	Mon 2/2/09	Fri 2/27/09
7	Subsurface Utility Location/Clearing	4 wks	Mon 2/16/09	Fri 3/13/09
8	Utility/Geophysical Survey	2 wks	Mon 3/16/09	Fri 3/27/09
9	Hydrogeologic and SW Evaluation Well Installation	6 wks	Mon 3/30/09	Fri 5/8/09
10	SW System Evaluation	12 wks	Mon 5/11/09	Fri 7/31/09
11	Chemical Lab Testing	4 wks	Mon 5/11/09	Fri 6/5/09
12	Groundwater Monitoring, Slug Tests, Pumping Test	6 wks	Mon 5/25/09	Fri 7/3/09
13	Groundwater Modeling	24 wks	Mon 3/2/09	Fri 8/14/09
14	Geotechnical Borings	6 wks	Mon 8/17/09	Fri 9/25/09
15	Geotechnical Lab Testing	4 wks	Mon 9/21/09	Fri 10/16/09
16				
17	**Reporting and Approach Development**	**60 days**	**Mon 10/19/09**	**Fri 1/8/10**
18	Investigation Findings Report	12 wks	Mon 10/19/09	Fri 1/8/10
19	Findings Meeting with NYSDEC	0 days	Fri 1/8/10	Fri 1/8/10
20				
21	**RAWP Development**	**185 days**	**Mon 1/11/10**	**Fri 9/24/10**
22	Cutoff Wall Design Development	12 wks	Mon 1/11/10	Fri 4/2/10
23	75% Design: National Grid Review, Edits, Submittal	4 wks	Mon 4/5/10	Fri 4/30/10
24	75% Design: NYSDEC Review and Comments	9 wks	Mon 5/3/10	Fri 7/2/10
25	95% Design: National Grid Review, Edits	4 wks	Mon 7/5/10	Fri 7/30/10
26	Final Comments Meeting with NYSDEC	0 days	Fri 7/30/10	Fri 7/30/10
27	RAWP Finalization	4 wks	Mon 8/2/10	Fri 8/27/10
28	Final RAWP: NYSDEC Review and Approval	4 wks	Mon 8/30/10	Fri 9/24/10



Appendix B

Health and Safety Plan (HASP) [electronic only]

Appendix C

Field Sampling Plan (FSP) [electronic only]

Appendix D

Quality Assurance Project Plan (QAPP) [electronic only]

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau C, 11th Floor
625 Broadway, Albany, New York 12233-7014
Phone: (518) 402-9662 • **Fax:** (518) 402-9679
Website: www.dec.ny.gov

Joe Martens
Commissioner

October 8, 2014

William Ryan
Project Manager
Site Investigation & Remediation
National Grid
175 East Old Country Road
Hicksville, NY 11801

Re: Greenpoint Energy Center Former MGP
Newtown Creek Bulkhead Barrier Wall IRM
Site No. 224052

Dear Mr. Ryan:

The New York State Department of Environmental Conservation (Department) has reviewed the data collected during the 2009 Interim Remedial Measure (IRM) Investigation and the 2012 / 2013 Phase 1 Remedial Investigation for the Greenpoint Energy Center Former MGP.

Based on this review, the Department has determined that the expedited design and construction of a barrier wall along the site bulkhead adjacent to Newtown Creek as an interim remedial measure (IRM) is not necessary at this time. The selection of a remedy for the site will be made following the completion and review of the Remedial Investigation and Feasibility Study Reports. Please understand that no remedial technologies have been eliminated for further consideration, at this time, from any future site-wide remedy.

Sincerely,

Henry T. Willems
Engineering Geologist 1

ec: W. Ryan, National Grid
T. Leissing, National Grid
G. Cross, NYSDEC
G. Heitzman, NYSDEC
I. Beilby, NYSDEC
D. Hetrick, NYSDOH

nationalgrid

Tracey Bell
Manager
Environmental Asset Management

April 9, 2010

Mr. Amen M. Omorogbe, P.E.
Project Manager
New York State Department of Environmental Conservation
MGP Remedial Section, Division of Environmental Remediation
Bureau of Western Remedial Action, 11th Floor
625 Broadway
Albany, New York 12233-7017

Re: Supplemental Pre-Design Investigation Work Plan Transmittal
Cutoff Wall Interim Remedial Measure
Greenpoint Energy Center
Brooklyn, New York
Site No. 224052

Dear Mr. Omorogbe:

On behalf of National Grid, enclosed is the Supplemental Pre-Design Investigation Work Plan for the Greenpoint Energy Center Site for your review and approval.

The work plan addresses data needs related to final selection of a cutoff wall alignment and type at the facility. It also includes additional sediment constituent analyses designed to bring it into conformance with the Newtown Creek PRP Group's proposed work plan for the Newtown Creek RI. Therefore, per our discussion today, the work plan is also copied to USEPA.

Please let me know if you have any questions or would like to discuss this further, feel free to contact me at 718-963-5645 or by e-mail at tracey.bell@us.ngrid.com.

Sincerely,

for

Tracey Bell
Manager

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Attachments

cc:

C. Doroski (HYSDOH)
A. Carpenter (US EPA)
C. Kwan (US EPA)
M. Mintzer (US EPA)

MZ/jp H:\WPROC\Project\KEYSPAN\Greenpoint\2010 Investigation\Greenpoint SIWP Final 4-7-2010.docx

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Tracey Bell
Manager
Environmental Asset Management

April 8, 2010

Mr. Amen M. Omorogbe, P.E.
Project Manager
New York State Department of Environmental Conservation
MGP Remedial Section, Division of Environmental Remediation
Bureau of Western Remedial Action, 11th Floor
625 Broadway
Albany, New York 12233-7017

Re: Supplemental Pre-Design Investigation Work Plan
Cutoff Wall Interim Remedial Measure
Greenpoint Energy Center
Brooklyn, New York
Site No. 224052

Dear Mr. Omorogbe:

National Grid is submitting for your review and approval this Supplemental Pre-Design Investigation Work Plan (SIWP) in support of the development of a Cutoff Wall Interim Remedial Measure (IRM) at the Greenpoint Energy Center at 287 Maspeth Avenue, Brooklyn, New York (Figure 1). This work plan is based on the findings of the original NYSDEC-approved Pre-Design Investigation Work Plan (IWP) dated January 9, 2009, conducted over the past year. This SIWP is required to further define geotechnical, geologic, hydrogeologic and environmental conditions at the site. Of specific interest is the southern bulkhead area along Newtown Creek. The focus of this SIWP is to:

- Further assess the subsurface presence of dense non-aqueous phase liquid (DNAPL) inboard and outboard of the bulkhead/dock structure, and in the sediments offshore along the southern alignment of the structure implemented in a phased approach.
- Further assess the geotechnical and geologic conditions along the bulkhead.
- Refine the understanding of the hydrogeologic regime in the southeast quadrant of the site.
- Abandon GPEC-MW-1 because the PVC casing was compromised due to the presence of DNAPL. Reinstall GPEC-MW-1 using steel components.

As detailed in the IWP, we will summarize all data in an Investigation Findings Report that we will provide to the NYSDEC. And upon selection of a proposed design approach, National Grid will meet with the NYSDEC to discuss the investigation findings and proposed design approach to obtain concurrence on a final basis of design.

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The Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and site-specific Health and Safety Plan (HASP) developed and previously approved for the IWP will be used for field activities of the SIWP and are therefore not included with this submittal.

PROPOSED SCOPE OF WORK

Field investigations will be conducted to acquire, geotechnical, geologic, hydrogeologic and environmental data. The field investigation will consist of three main tasks:

- Task 1 Hydrogeologic Study: will consist of installing new monitoring wells located to evaluate vertical head potential flow and to replace GPEC-MW-1.
- Task 2 Geotechnical/Environmental Study: will consist of advancing borings to further assess environmental, geotechnical and geologic conditions. Borings will be installed along the southern alignment of the bulkhead/dock structure in a phased approach to assess the potential of DNAPL migration from the inboard side of the bulkhead/dock structure to the outboard face of the structure. Should the inboard borings be free of DNAPL, the outboard borings will not be performed. In addition, two outboard borings along the north alignment of the bulkhead/dock structure will be performed to gather geotechnical data related to the deeper stratigraphy at former Mussel Island and farther north adjacent the Liquefaction Plant.
- Task 3 Sediment Sampling: will consist of collecting sediment cores from Newtown Creek to further assess environmental conditions in the creek.

Figure 2 shows the approximate locations of the proposed borings and wells. Final locations may be modified pending evaluation of potential obstructions through utility clearance activities.

Task 1 - Hydrogeologic Study

We propose to install monitoring wells at the six locations identified in Table 1 to gather additional hydrogeologic data to support the groundwater model and to further assess the groundwater flow regime. Wells proposed include:

- A water table monitoring well adjacent to GPEC-MW-3 along the bulkhead dock.
- A deep monitoring well in the vicinity of the guard shack at the Maspeth site entrance to approximately 100 feet, targeting a potential aquatard and screened at depth to aid in defining deep groundwater flow.
- A deep monitoring well adjacent to GPEC-MW-11 (south of LNG Tank No. 2) to approximately 100 feet, targeting a potential aquatard and screened at depth to aid in defining the deep groundwater flow.

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- A three-well cluster north of the Transportation Building to an approximately 100 feet, targeting a potential aquatard and screened at the water table, in the intermediate zone, and at a greater depth to aid in defining horizontal and vertical groundwater flow in this area.
- Abandon and reinstall GPEC-MW-1 using steel components.

The monitoring well borings will be extended to the target depths listed in Table 1 or at least 10 feet below the deepest MGP-related contaminant observed in the boring, based on field screening described in the FSP. The monitoring wells will be constructed as described in Section 7 of the FSP.

Table 1

Location	**Approximate Boring Depth (Below the Ground Surface)**	**Approximate Monitoring Well Screen Interval (Below the Ground Surface)**
Adjacent to GPEC-MW-3	100 feet (Potential Aquatard)	Spanning the water table
Vicinity of the guard shack (Maspeth Ave. entrance)	100 feet (Potential Aquatard)	80 to 100 feet
Adjacent to GPEC-MW-11	100 feet (Potential Aquatard)	80 to 100 feet
Well 1 of 3 north of the Transportation Building	30 feet	Spanning the water table
Well 2 of 3 north of the Transportation Building	60 feet	40 to 60 feet
Well 3 of 3 north of the Transportation Building	100 feet (Potential Aquatard)	80 to 100 feet

The first 8 feet of each soil boring will be cleared for utility obstructions by soft-dig techniques. Below, soil samples will be collected and logged continuously from each boring location in accordance with the FSP. The borings will be advanced using roto-sonic drilling techniques with 6-inch-diameter casing.

If DNAPL/tar impacts are observed above a change in formation or potential confining layer in a boring, 7-inch casing will be advanced to isolate the contaminated zone. The 7-inch casing will be seated in a 5-foot-thick column of bentonite slurry. The bentonite slurry will be used to prevent potential downward migration of the contamination along the walls of the casing.

Once the 7-inch casing has been seated in the bentonite, soil sampling will continue below the 7-inch casing. After collection of each sample a 6-inch casing will be advanced to case the boring below the bottom of the 7-inch casing. The boring will be terminated at 100 feet or in the potential aquatard. If tar is present near the termination point, the boring will be advanced to 10 feet below the bottom of observed tar.

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After completing each boring, the 6-inch casing will be removed incrementally as the boring is grouted. If 7-inch isolation casing is used, once the grout has reached the bottom depth of the 7-inch casing, the 6-inch casing will be completely removed. Grouting will then proceed with incremental removal of the 7-inch casing. Drilling methods and procedures are described in the FSP.

Up to three soil samples per boring will be selected for chemical analysis at the depth intervals and parameters described in the section below titled Laboratory Chemical Testing.

Drilling equipment (i.e., drilling rods, auger, casing, etc) will be decontaminated between each sample location as described in the FSP. Soil cuttings and decontamination fluids will be collected in 55-gallon United States Department of Transportation (USDOT) drums or fractionation tank and will be disposed of by National Grid

Two rounds of groundwater elevation readings will be performed at all monitoring wells, each round at both high and low tide.

Task 2 – Geotechnical/Environmental Investigation

Up to eight soil borings will be performed as part of the geotechnical/environmental investigation to further assess the presence of DNAPL/tar inboard of, outboard of, and within the dock and bulkhead zone. The geotechnical borings will be advanced along the inboard and outboard face of the bulkhead/dock structure, shown in Figure 2, using roto-sonic drilling methods.

The bulkhead/dock structure consists of a pile-supported timber deck 40 feet wide capped with 7 feet of either soil fill or concrete. Previous borings were installed about 25 to 35 feet inland of the inboard face of the bulkhead/dock structure to document the historic fill and natural formation along the creek shoreline.

Three inboard borings will be installed between GPEC-MW-1 and GPEC-MW-2 located as close to the inboard face of the bulkhead/dock structure, as practical. Existing utilities and operational features will affect the final location of these borings. If DNAPL is present in a boring, an additional boring on the outboard side of the bulkhead/dock structure opposite of the inboard boring will be performed.

In addition, two borings will be performed for primarily geotechnical information; one between GPEC-GT-18 and GPEC-GT-20 and one between GPEC-GT-20 and GPEC-GT-22.

All of the borings in this task will be advanced to intersect a potential aquatard at about 100 feet below the ground surface. The borings will continue at least 10 feet below the deepest MGP-related contaminant observed in the boring, based on field screening described in the FSP. Upon completion, the borings will be tremie grouted to the ground surface using a

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cement/bentonite slurry mixture. For outboard borings, the borings will tremie grouted to about 10 feet below the mudline and backfilled with bentonite to the mudline.

The first 8-feet of onshore borings will be cleared for utility obstructions by soft-dig techniques. Standard Penetration Tests (SPTs) and core sample collection will be performed. Sampling will be performed continuously through the entire boring. SPTs will be performed at 5-foot intervals in native deposits from 60 feet below the ground surface to the termination depth of the boring. Soil samples will be logged in general accordance with Unified Soil Classification System.

If DNAPL/tar impacts are observed above a change in formation or potential confining layer in a boring, 7-inch casing will be advanced to isolate the contaminated zone. The 7-inch casing will be seated in a 5-footthick column of bentonite slurry. The bentonite slurry will be used to prevent potential downward migration of the contamination along the walls of the casing.

Once the 7-inch casing has been seated in the bentonite, soil sampling will continue below the 7-inch casing. After collection of each sample a 6-inch casing will be advanced to case the boring below the bottom of the 7-inch casing. The boring will be terminated at 100 feet or in the potential aquatard. If tar is present near the termination point, the boring will be advanced to 10 feet below the bottom of observed tar.

After completing each boring, the 6-inch casing will be removed incrementally as the boring is grouted. If 7-inch isolation casing is used, once the grout has reached the bottom depth of the 7-inch casing, the 6-inch casing will be completely removed. Grouting will then proceed with incremental removal of the 7-inch casing. Drilling methods and procedures are described in the FSP.

Up to three soil samples per boring will be selected for chemical analysis at the depth intervals and parameters described in the section below titled Laboratory Chemical Testing. Drilling equipment (i.e., drilling rods, auger, casing, and/or macro-core sampler) will be decontaminated between each sample location as described in the FSP. Soil cuttings and decontamination fluids will be collected in 55-gallon United States Department of Transportation (USDOT) drums, lined roll-off dumpster or fractionation tank and will be disposed of by National Grid following characterization.

The borings located offshore on Newtown Creek will require a barge-mounted drill rig and will require permits/approval from the U.S. Coast Guard, U.S. Army Corps of Engineers, and local law enforcement, as appropriate.

Laboratory Chemical Testing

Soil and groundwater samples collected during the above investigation will be tested for chemical contaminants potentially associated with the former MGP operations, other historical operations, and for treatment and waste characterization purposes. Samples will be analyzed by a New York State Environmental Laboratory Accreditation Program (ELAP)-certified laboratory.

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Up to three soil or sediment samples per boring will be selected for chemical analysis as follows.

- The depth interval indicating the greatest apparent degree of contamination within 8-feet of ground surface, to characterize the utility depth interval or exposure depth for land based borings.
- The depth interval exhibiting the apparent greatest degree of tar-related impacts based on visual observation over the depth of the boring.
- For intermediate zone monitoring well locations, a sample will be collected at the depth of the center of the well screen.
- The boring termination depth.
- If no evidence of contamination is observed, then a sample will be collected from the depth of the observed groundwater table.

Soil samples will be collected over approximate 2-foot depth intervals. The greatest degree of contamination will be identified by photoionization detector (PID) screening and by visual and olfactory observations. Field screening procedures are described in the FSP.

Each soil sample will be analyzed for:

- Volatile organic compounds (VOCs) by the United States Environmental Protection Agency (EPA) SW-846 method 8260B
- Semivolatile organic compounds (SVOCs) by EPA method 8270C
- Target Analyte List (TAL) metals by EPA method 6000/ 7000 series
- Polychlorinated biphenyls (PCBs) by EPA method 8082.
- Free cyanide extraction by EPA method 9013A and analysis by Microdiffusion, American Society for Testing and Materials (ASTM) method D4282-02.
- Hexavalent chromium by EPA method 3060A/7196
- Total organic carbon by EPA method 9060 (select samples).

Monitoring wells will be sampled for site contaminants of potential concern. Monitoring wells will be purged and sampled in accordance with the FSP. Each groundwater sample will be analyzed for:

- VOCs by EPA method 8260B
- SVOCs by EPA method 8270C
- TAL metals by EPA method 6000/7000 series
- PCBs by EPA method 8082
- Total cyanide by EPA Method 9012B

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- Free cyanide extraction by EPA method 9013B and analysis by Microdiffusion, ASTM method D4282-02.

If DNAPL accumulation is present in any well, no groundwater sample will be collected for laboratory analysis.

QA/QC procedures are detailed within the QAPP (Previously submitted to the NYSDEC). QA/QC samples will include blind duplicate soil or sediment samples, Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples, and equipment rinsate blank samples. The quality control samples will be completed on a frequency of 1/20 per matrix. An approved ELAP laboratory will perform the analyses. One trip blank will be included per shipment of samples to the laboratory.

Task 3 – Sediment Sampling

The collection of sediment samples from the Newtown Creek at 18 locations is proposed, as shown in Figure 2.

Surface Sediment Sampling

Surface sediment samples will be collected using an Eckman sampler, modified Eckman sampler, a modified Van Veen sampler, a Petit Ponar sampler, or similar sampling device as appropriate for the type of sediment sample being collected. Surface sediment samples will be collected to characterize the chemical nature of the surface sediments.

Surface sediments will be collected from 0 to 0.33 feet (0 to 10 cm) below the mudline. The surface mudline is defined as the interface between bulk sediments and overlying surface water. This sampling depth is consistent with the typical depth for the biologically active zone sampled in coastal sediments

Surface sediment samples will be collected at the locations shown on Figure 2. The sample locations shown on this figure are approximate and may be modified based on field conditions.

The surface sediment samples will be analyzed for the following:

- TAL metals plus tin
- TCL VOCs plus tentatively identified compounds (TICs)
- TCL SVOCs plus TICs
- 1,4-dioxane
- NOAA list organochlorine pesticides (by gas chromatograph/electron capture detector (GC/ECD))
- TCL PCBs(as Aroclors)
- chlorinated herbicides
- PAHs and alkyl PAHs

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- n-alkanes and isoprenoids including diesel range organics (DRO) and TPH ranges
- TOC
- soot carbon
- ammonia
- sulfide
- total nitrogen
- total phosphorus
- cyanide
- total solids.

Additional samples from each location will be frozen at -20 degrees Celsius (°C) and archived. Of these archived surface sediment samples, 25 percent will be selected for analysis for NOAA list organochlorine pesticides (by high resolution mass spectrometer [HRMS]), TCL dioxins and furans, and methyl mercury. These samples will be selected to be spatially distributed throughout the sample area and among varying sediment types (e.g., gravel, sand, silt, etc.).

Samples will be analyzed by a New York State ELAP-certified laboratory. QA/QC procedures are detailed within the QAPP (Previously submitted to the NYSDEC). QA/QC samples will include blind duplicate soil or sediment samples, Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples, and equipment rinsate blank samples. The quality control samples will be completed on a frequency of 1/20 per matrix. One trip blank will be included per shipment of samples to the laboratory.

Sample logs and field notes of all surface sediment samples will be maintained as samples are collected. During sample collection, the substrate type will be described along with visual evidence of impacts (e.g., hydrocarbon-like sheens), odors, and date and time of sample collection. Sample logs will include location coordinates and reported elevations referenced to the New York State Plane Eastern Zone of the North American Datum of 1983 and the North American Vertical Datum of 1988, respectively. The survey will be performed at a horizontal accuracy of 1 foot (30.48 cm) and a vertical accuracy of 0.1 foot (3.05 cm), and location by DGPS. In addition, photographs will be taken of each sample.

Subsurface Sediment Sampling

Subsurface sediment cores will be advanced using vibracore methods to achieve contact with the native (pre-navigation channel) soil unit or to a depth of approximately 20 feet (610 cm) below the mudline, whichever comes first. Sediment samples will be collected from each core at the following eight intervals below the mudline: (1) 0.33 to 0.66 feet (10 to 20 cm); (2) 0.66 to 1.97 feet (20 to 60 cm); (3) 1.97 to 3.28 feet (60 to 100 cm); (4) 3.28 to 6.56 feet (100 to 200 cm); (5) 6.56 to 9.84 feet(200 to 300 cm); (6) 9.84 to 13.12 feet (300 to 400 cm); (7) 13.12 feet (400 cm) to the top of the native soil unit (this sample interval will terminate at the contact with the native soil unit); and (8) the native soil unit.

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Where the native soil unit is encountered at a shallower depth, fewer samples will be collected (e.g., if the native materials are encountered at 240 cm below mudline, a sediment sample would be collected from the 200 to 240 cm interval, followed by a sample of the native materials). These sampling intervals will be followed if the observed stratigraphy appears homogenous with depth. The sampling intervals may be modified around sediment contacts if variations in sediments are observed. If native soil cannot be identified or cannot be reached, the sampling intervals identified above will be used.

Grab surface sediment samples will be collected coincident to each subsurface sediment core location. For that reason, the 0- to 0.33-feet interval will not be collected from the core sample. The proposed sediment core sampling locations are shown on Figure 2. The sample locations shown on this figure are approximate and may be modified based on field conditions.

The subsurface sediment samples will be analyzed for the following constituents:

- TAL metals plus tin
- TCL SVOCs plus TICs
- the NOAA list organochlorine pesticides (by GC/ECD)
- TCL PCBs (as Aroclors)
- chlorinated herbicides
- PAHs and alkyl PAHs
- n-alkanes
- isoprenoids including DRO and TPH ranges
- TOC,
- soot
- carbon
- ammonia
- sulfide
- total nitrogen
- total phosphorus
- cyanide
- total solids.

A minimum of 25 percent of the samples collected will be selected for analysis for TCL VOCs plus TICs based on field screening using a photoionization detector (PID). Samples will be selected for VOC analysis from zones where PID readings above background are observed as well as zones above and below the zones with readings above background PID readings.

Additional samples from each location will be frozen at -20°C and archived. Of these archived subsurface sediment samples, a minimum of 25 percent will be selected for analysis for organochlorine pesticides (by HRMS), TCL dioxins and furans, and methyl mercury. These samples will be selected to be spatially distributed throughout the sampling area and among varying sediment types (e.g., gravel, sand, silt, etc.) and based on the chemical analytical results for the other constituents and analytical methods.

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Samples will be analyzed by a New York State ELAP-certified laboratory. QA/QC procedures are detailed within the QAPP (Previously submitted to the NYSDEC). QA/QC samples will include blind duplicate soil or sediment samples, Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples, and equipment rinsate blank samples. The quality control samples will be completed on a frequency of 1/20 per matrix. One trip blank will be included per shipment of samples to the laboratory.

Core logs and field notes of all sediment core samples will be maintained as samples are collected and processed. During sample collection, the substrate type will be described along with visual evidence of impacts (e.g., hydrocarbon-like sheens), odors, date and time of sample collection, length and depth of each sediment type (visual determination), and a qualitative notation of coring resistance.

Core logs will include location coordinates and reported elevations referenced to the New York State Plane Eastern Zone of the North American Datum of 1983 and the North American Vertical Datum of 1988, respectively. The survey will be performed at a horizontal accuracy of 1 foot (30.48 cm) and a vertical accuracy of 0.1 foot (3.05 cm), location by DGPS. In addition, photographs will be taken of each core.

The soil samples will be collected and logged continuously from each exploration location in accordance with the FSP. The soil will be classified in accordance with the Unified Soil Classification System.

Coring equipment will be decontaminated between each sample location as described in the FSP. Soil cuttings and decontamination fluids will be collected in 55-gallon United States Department of Transportation (USDOT) drums, and will be disposed of by National Grid.

The sediment sampling will require a barge-mounted drill rig and will require permits/approval from the U.S. Coast Guard, U.S. Army Corps of Engineers, and local law enforcement, as appropriate.

NAPL ASSESSMENT

A non-aqueous phase liquid (NAPL) assessment will be perform on DNAPL tar or light non-aqueous phase liquid (LNAPL) hydrocarbons to evaluate the distribution, potential recoverability, physical and chemical characteristics of the materials. All wells potentially containing NAPL based on boring observations will be gauged using an oil/water interface probe. If measurable NAPL is observed, it will be bailed or pumped from the well and the volume of removed material recorded. The NAPL removed from a well will be containerized for disposal.

The recovery rate will be assessed of the NAPL through periodic measurements with an oil/water interface probe. Characteristics of the NAPL will be documented. If DNAPL is present, up to

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three samples will be collected and analyze for waste characterization purposes and to measure the density and viscosity of the DNAPL.

SURVEY

A New York State Licensed Land Surveyor will survey the exploration locations. The elevation of each exploration to ±0.01 foot will be measured and will be tied into the Site benchmark. All horizontal coordinates and vertical elevations will be referenced to the New York State Plane Eastern Zone of the North American Datum of 1983 and the North American Vertical Datum of 1988, respectively. For the outboard explorations in Newtown Creek, the horizontal coordinates will be measured using Differential Global Positioning System (DGPS) survey methods. The depth to mudline will be measure at each sampling location with an accuracy of 0.1 feet.

DATA VALIDATION AND MANAGEMENT

Test America will provide New York State Category B data deliverables. The test results will be validated in general accordance with the New York State Analytical Services Protocols (ASP). A data validation report will be prepared that will summarize the data and will discuss its appropriateness for use.

REPORT PREPARATION

The data will be incorporated into the site-wide database and will be used to supplement the understanding of the conditions at the Site. The findings of this investigation will be summarized along with the findings of the original IWP in an Investigation Findings Report.

SCHEDULE

We will commence the SIWP investigation mobilization upon NYSDEC approval of the work plan. We anticipate that the field investigation program will last approximately 12 to 16 weeks.

If you have any questions or require additional information, please feel free to contact me at 718-963-5645 or by e-mail at tracey.bell@us.ngrid.com.

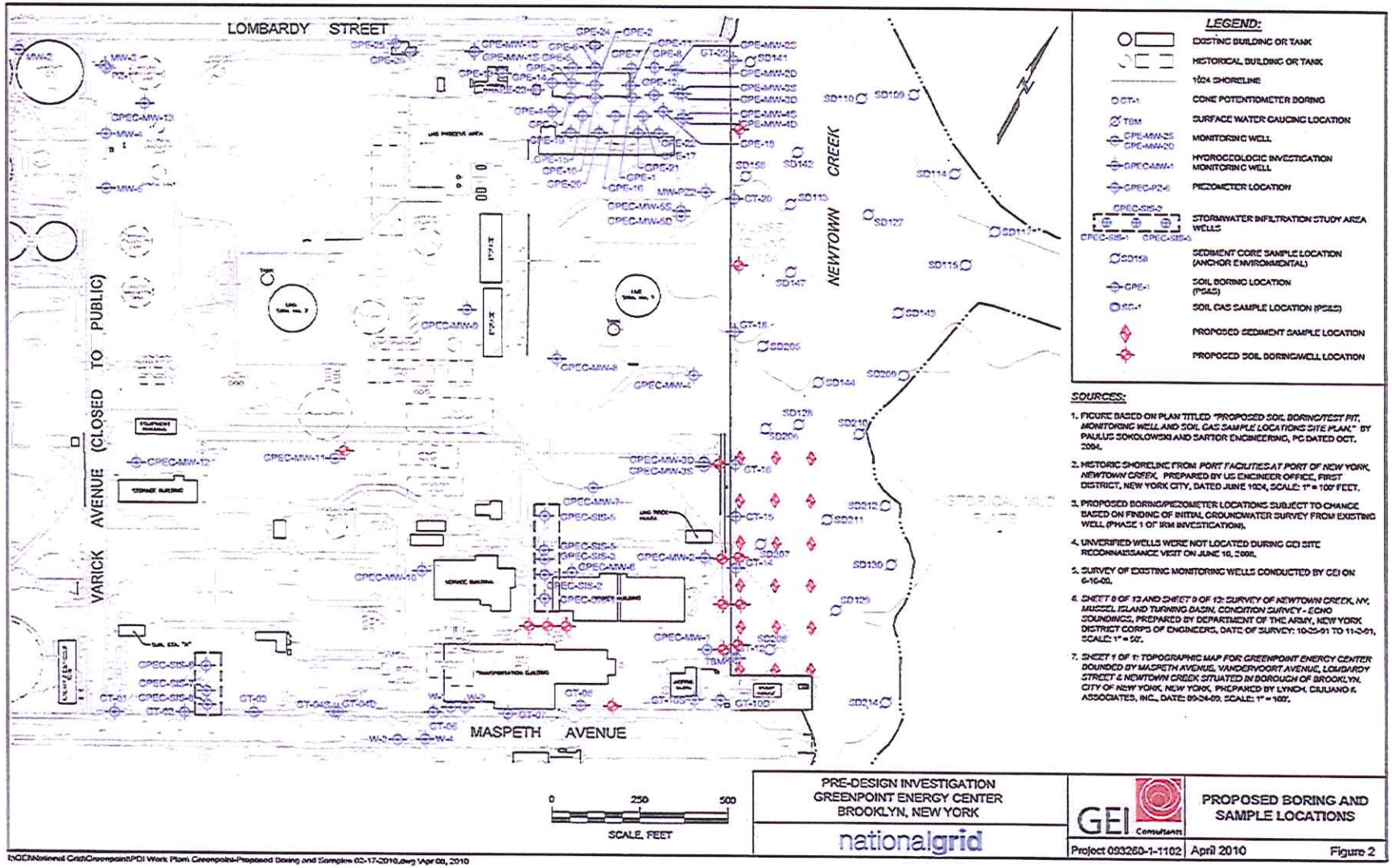
Sincerely,

Tracey Bell for
Manager

Attachments

cc:
C. Doroski (HYSDOH)

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GEI Consultants

PROPOSED BORING AND SAMPLE LOCATIONS

Project 093260-1-1102 | April 2010 | Figure 2

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