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*Prepared for:*

*King County Department of Metropolitan Services*

*Prepared by:*

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# *COMPLIANCE MONITORING PLAN*

*Metro South Dearborn Facility*
*Seattle, Washington*

***September 14, 1995***

***Project No. E1/920307.11***

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September 14, 1995

**Ms. Maura S. O'Brien**
*Metro Projects Manager*
Toxics Cleanup Program
Washington State Department of Ecology
NW Regional Office
3190 - 160th Avenue SE
Bellevue, Washington 98008-5452
206/ 649-7249

*Re: Final Compliance Monitoring Plan Metro South Dearborn Facility, Seattle, Washington Enviros Project Number E1/920307.11*

Dear Ms. O'Brien:

Please find attached the final draft of the Compliance Monitoring Plan (CMP) for the Metro Dearborn Facility. The CMP has been modified to reflect: a meeting held at Ecology April 26, 1995 to discuss the draft, Ecology comments in your letter dated July 14, 1995, the decision to allow off-site treatment of contaminated soils at the TPS facility in Tacoma, and recent information provide by TPS regarding their analytical monitoring program.

Specifically, the following changes have been made:

- Section 1 (pages 1 and 3, Table 1) has been updated to indicate that soils will be treated off-site and that TPS will be performing some of their own analytical testing.

- Grab samples rather than composite samples will be collected for verification sampling of soils, whereas limited compositing may be used for soil screening (page 7).

- The treated soil testing frequency has been reduced from 1 sample per 350 tons to 1 sample per 500 tons to account for the verification testing to be conducted by TPS through an independent lab (page 8 and Table 4). This change in Enviros sampling frequency only reduces the total sample number by 10. TPS tests 5 samples per 3000 tons for total petroleum hydrocarbons (TPH) by EPA Method 418.1, and 3 samples for total arsenic, cadmium, chromium and lead (presumably by EPA Methods 6010/7000). According to TPS, no soils treated for polycyclic aromatic hydrocarbon (PAH) contamination will be returned to Dearborn, so they do not plan on testing for PAHs.

- The reference to potential baseline testing of existing wells W-1, W-3, W-4, W-6 and W-7 was deleted (page 9). New monitoring wells to be installed were specified for baseline testing.

- Testing of semi-volatiles and volatiles was specified as a one-time sampling event, rather than a possible annual sampling program (page 13).

- The Ecology document *Guidance on Sampling and Data Analysis Methods (1995)* was specified as a reference for data evaluation procedures (page 15).

- The 95% upper confidence limit about the true population mean was specified as the concentration for verifying cleanup. In addition, WAC 173-340-708(11)(d) was cited and the criteria of no single sample exceeding twice the cleanup level nor more than 10% of the samples exceeding the cleanup level were specified (page 16).

- Total sample numbers in Table 4 were adjusted to account for testing to be performed by TPS. The PID was specified for supplemental use in performance monitoring of air emissions.

Enviros recognizes that portions of the CMP may be modified after the pilot test to account for a greater number of piezometers and/or wells. Please call if you have any questions, thank you for comments and input on the draft version of this document.

Sincerely,

**Enviros Incorporated**

Michael S. Surowiec, PG, PE
Associate Geoenvironmental Engineer
(206) 828-2506

Attachment

cc: Judy Riley - Manager Facilities Programs, METRO
J. Paul Miller, PE - Project Engineer/Construction, METRO
Files

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## Tables



## Figures

# 1.0 INTRODUCTION

## 1.1 Project Description

This plan provides compliance monitoring requirements (in accordance with WAC 173-340-410) and sampling and analysis requirements (in accordance with WAC 173-340-820) for the King County Department of Metropolitan Services (Metro) South Dearborn Site Remediation. The site remediation will include work conducted under the Consent Decree issued by the Department of Ecology (Ecology) for cleanup of soils and groundwater at Metro's South Dearborn Facility in Seattle, Washington. The work includes the following site activities:

- Excavation of four (4) areas identified to be contaminated with petroleum hydrocarbon products. These areas have been designated Excavation Areas A through D, as shown in Figure 1;
- Transportation and off-site treatment of petroleum-contaminated soils by thermal desorption at the TPS facility in Tacoma, Washington;
- Backfilling of excavations with thermally treated soils or uncontaminated overburden soils; and
- Subsurface implementation of *in situ* vapor extraction/air sparging (VE/AS) for treatment of groundwater.

Work is expected to begin in late September of early October 1995. Excavation and thermal treatment of contaminated soils is required to be completed by December 31, 1995, but may be completed be November 1995. The subsurface installation, pilot testing and final configuration of the *in situ* groundwater treatment system is required to be completed no later than March 31, 1996. *In situ* groundwater remediation will continue until a practicable benefit is achieved. The treatment period is estimated to continue for a maximum of two years, with an option for an additional 6 months of operation if such an extension is deemed warranted by Ecology.

## 1.2 Compliance Monitoring Requirements

The compliance monitoring requirements as stipulated in the Consent Decree between Metro and Ecology are summarized here. They include: protection monitoring of human health and the environment during cleanup activities; performance monitoring to assess the efficacy of remediation activities as they occur; and verification/confirmation monitoring to assess site conditions at the time of cleanup of site soils, during long-term groundwater monitoring and at the time of final site closure for environmental concerns.

### 1.2.1 Protection Monitoring

The purpose of protection monitoring is to confirm that human health and the environment are adequately protected during the cleanup action. During remediation activities, various hazards associated with construction activities and the presence of toxic and hazardous substances could result in risks to human health or the environment. In order to mitigate these risks, guidelines will be established which identify potential threats to worker safety or the environment and provide for proper protective measures. These guidelines will be established in the Accident Prevention Program (APP), which is discussed in Section 3.0.

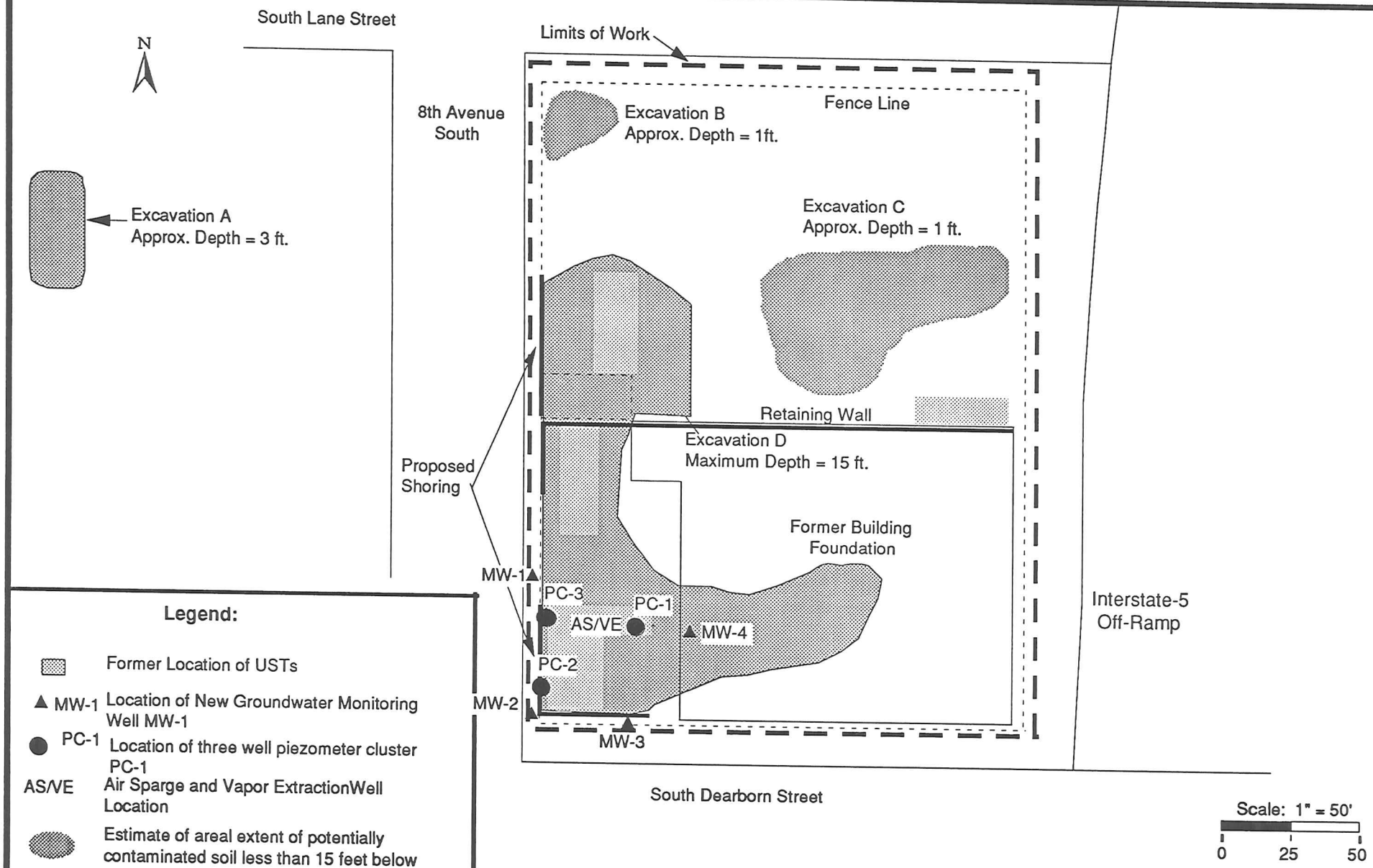


Figure 1: Excavation Areas and Final Well Installation Locations
South Dearborn Facility, Seattle, Washington.

Drawn By: MBG Revised By: AIS Approved By: MSS Date: 9/14/95

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### 1.2.2 Performance Monitoring

The purpose of performance monitoring is to assess the efficacy of remedial actions as they occur and provide preliminary confirmation that the remedial action has attained cleanup standards and goals as established in the Cleanup Action Plan (CAP).

*Soil Remediation*

Performance monitoring of the cleanup of excavated soils will be conducted by Enviros and consist primarily of soil sampling, contamination screening and chemical analysis for target contaminants. Specifically, it will include soil screening and analysis during excavation, preliminary verification of remaining contaminant concentrations upon completion of each excavation, and analytical testing of thermally treated soils. Performance monitoring will rely on soil screening using a photoionization detector (PID) and water sheen tests, and analysis of soils for total petroleum hydrocarbons (TPH) by Enviros' laboratory using an infrared spectrophotometer (IR). Approximately 10% of the performance monitoring samples will be split and tested at an independent laboratory to verify the adequacy of soil screening and preliminary analytical testing. The TPS facility also tests treated soils onsite for TPH as part of performance monitoring of their process.

*Groundwater Treatment System*

Performance monitoring of the *in situ* groundwater treatment system will be conducted during system start-up and pilot testing is expected to last four (4) weeks. The performance monitoring will consist of sampling and analysis of air emissions and groundwater concentrations. In addition, measurement of applicable system operating parameters such as hydraulic head, vacuum and injection pressure, PID measurements of volatile organic air emissions and flow rates will be performed during treatment system startup. Baseline air emission and groundwater contaminant concentrations will be obtained and compared to results at the conclusion of a pilot test. Analytical testing of air samples from the air emission control equipment and petroleum hydrocarbon concentrations in groundwater will be performed by an independent laboratory. Sample collection and treatment system equipment monitoring will be performed by Enviros.

### 1.2.3 Verification/Confirmation Monitoring

The purpose of verification/confirmation monitoring is to assess final site conditions as compared to cleanup standards and goals established in the CAP. Verification/confirmation monitoring will be performed at the time of cleanup of site soils, during long-term groundwater monitoring and at the time of final site closure.

*Soil*

Verification/confirmation sampling will be performed on soils remaining in the sidewalls and floors of all final excavations at the South Dearborn site. In addition, 10% sample splits of the performance monitoring samples (Enviros IR Laboratory) collected from thermally treated soils will be analyzed independently to serve as verification of the soil remediation process. Enviros will collect samples and have them tested at an independent laboratory to demonstrate compliance with soil cleanup standards and goals as established in the CAP. To independently verify treatment, the TPS facility also has their treated soils analyzed by an off-site laboratory.

*Groundwater Treatment System*

Verification/confirmation monitoring will be performed to confirm the long-term effectiveness of the cleanup action and will consist of groundwater and air emission sampling and analysis. As stipulated in the Consent Decree, this sampling will be performed on a semi-annual basis. However, system operating parameters described above will be monitored more frequently on a bi-monthly basis, depending on the observed variability of system operation. Enviros will perform all system monitoring and collect all samples for independent laboratory analysis to demonstrate compliance with soil cleanup standards and goals as established in the CAP.

### 1.3 Media Description

The vadose zone soils to be remediated are within the upper 15 feet of the ground surface (maximum excavation depth required by Consent Decree) and include silty sands and silty clays (SM and CL soils in the USCS system, respectively).

The groundwater treatment system will be installed in sandy soils (SP soils) with an estimated porosity of 0.35. Unsaturated soils have an estimated intrinsic air permeability of $10^{-9}$ to $10^{-8}$ $cm^2$ (0.1 to 1 darcy) and the saturated soils have an estimated hydraulic conductivity of $10^{-6}$ ft/sec ($3 \times 10^{-8}$ cm/sec). The average groundwater flow gradient is 0.001 ft/ft and the depth to groundwater is approximately 39 feet below grade.

Site and media conditions are described in other documents regarding the site (Enviros, Inc. August 8, 1992, October 22, 1993 and November 3, 1994).

## 2.0 PROJECT TEAM RESPONSIBILITIES

Metro will act as the primary contact with any regulatory agencies involved in the project. Protection of worker health and safety will be the direct responsibility of each governmental agency (e.g., Metro) or private employer (e.g., the Contractor and Enviros) with personnel involved in cleanup action activities. Protection monitoring of the work-area environment will be the responsibility of the Contractor. Worker health and safety issues and environmental protection issues will be identified and addressed in an APP (prepared in accordance with WAC 173-340-410(1)(a), WAC 173-340-810(1), Chapter 49.17 RCW, and 29 U.S.C. Sec. 651 et seq.) submitted by the Contractor to Metro for approval. In addition, Enviros will prepare and implement a Health and Safety Plan specific to the activities of Enviros personnel. Performance monitoring and confirmation monitoring will be the responsibility of Enviros, as established in Section 4.0 and Section 5.0. Project team responsibilities are summarized in Table 1.

## 3.0 PROTECTION MONITORING

The Contractor will prepare and implement an APP in accordance with the provisions of WAC 173-340-810, Chapter 49.17 RCW, 29 U.S.C. Sec. 651 et seq., and the Puget Sound Air Pollution Control Agency (PSAPCA) and which will outline the anticipated hazards and safety controls necessary to safeguard Contractor's employees, the public and other site personnel. It will be specific to the South Dearborn job and site, and meet federal, state and local jurisdictional requirements. The program will be reviewed by Metro for compliance prior to the start of work.

**Table 1:**
**Project Team Responsibilities**

| Task | Metro | Enviros | Analytical Lab | Contractor |
|---|---|---|---|---|
| Regulatory Agency Contact | x | | | |
| Protection of Site Personnel | x | x | | x |
| Protection of Work-Area Environment | | | | x |
| Onsite Construction/Installation | | | | x |
| Performance Monitoring of Cleanup | | x | | |
| Verification Sampling | | x | | x |
| Pilot Test and Treatment System O&M | | x | | |
| Analysis of Performance Mon. Samples | | x | x | |
| Analysis of Verification Samples | | | x | |
| Environmental Reporting | | x | | |

## 4.0 SOIL REMEDIATION MONITORING

### 4.1 Soil Excavation Performance Monitoring

The purpose of performance monitoring of excavated soils is to verify the removal of all soils contaminated at or above the cleanup level, and thereby minimize costs due to thermal treatment of uncontaminated soils. Enviros will perform field screening and analytical testing using an IR (Enviros IR Laboratory) to separate clean and contaminated soils and as a preliminary evaluation of TPH concentrations in completed excavations. Approximately 10% of the samples analyzed by the Enviros IR Laboratory will be split and tested by an independent laboratory.

#### 4.1.1 Sample Frequency and Locations

During excavation, Enviros will screen soils with a PID and water sheen tests. When screening is inconclusive or indicates that soil is not contaminated, soil samples will be collected for analytical testing in the Enviros IR Laboratory at a minimum frequency of one sample per 35 tons (25 cubic yards) of excavated soil. Precise sample locations will be determined in the field, in areas where residual contamination is most likely to be present.

#### 4.1.2 Sampling Procedures

Samples collected from the excavation floor will be either discrete grab samples or composite samples collected from two adjacent locations. For composite samples, equal aliquots of the two adjacent grab samples to be composited will be manually homogenized prior to analysis.

Samples will be collected in a manner which prevents cross-contamination between samples. Sampling tools will be decontaminated between samples, or new disposable sampling tools will be used. All tools or protective gloves which come into contact with soil samples will be composed of a non-reactive, inert material such as stainless steel, glass, or hydrocarbon-resistant plastics. If excavation machinery is employed for the purpose of collecting samples from deep excavations, samples will be collected from the relatively undisturbed soils in the center of the excavation bucket.

4.1.3 Sample Designation and Field Documentation

Samples collected for Enviros IR Laboratory analysis will be assigned sample names which provide sufficient information, along with field notes, that their origin is easy to determine. Enviros will keep detailed field notes which provide the following information for each sample:

- Date sample collected;
- Type of sample (discrete or composite, sidewall or floor); and
- Approximate location(s) of sample collection (with sketch if appropriate)

Field documentation for samples which are analyzed as 10% splits at an independent laboratory will also include chain-of-custody and sample preservation procedures described in Section 6.

4.1.4 Sample Analysis

Field screening may consist of a visual determination for highly contaminated soils, water sheen tests, or measurement of organic soil vapors with a portable PID. To measure organic vapors in soil with a PID, the soil vapor may be measured directly (when soils are highly contaminated and/or contaminants are volatile) by holding the probe near a freshly exposed soil surface, or samples may be placed in jars (when soils are not highly contaminated and/or contaminants are less volatile), sealed with aluminum foil, and measured by inserting the probe after the soil reaches ambient temperatures. The PID will be calibrated to 100 parts per million volume basis (ppmv) of isobutylene gas standard. PID calibration shall be performed the morning(s) of field activities and will be checked periodically during the day with the calibration gas.

Enviros IR Laboratory analysis of performance monitoring samples will be conducted by an IR and will consist of a modification of Ecology Method WTPH-418.1 Modified (Field 418.1). The results will be corrected for soil moisture content and the method will be modified to minimize loss of volatiles and allow for rapid turnaround. This analysis may be performed on-site in a mobile laboratory, or in an off-site laboratory, depending on sample volumes and required turn around times. Table 2 summarizes analytical testing parameters for performance monitoring sampling.

## 4.2 Post-Excavation Verification Monitoring

The purpose for post-excavation verification monitoring is to sample and analyze soils in final excavation boundaries to determine residual TPH concentrations. All post-excavation verification samples will be collected by Enviros, but will be analyzed at an independent laboratory.

4.2.1 Sample Frequency and Location

When performance monitoring analyses indicate that contaminants are below cleanup levels, excavation will be stopped and verification/confirmation monitoring samples will be collected from the excavation floor and sidewalls. A minimum of three samples will be collected from small excavations (such as Excavation "B"), or one sample for every 350 tons (250 cubic yards) of contaminated soil removed, whichever is greater. Discrete grab samples will be collected from areas of the excavation where performance monitoring indicates that residual contamination is most likely to be present. If there is no indication of residual contamination, then samples will be collected from the floor and sidewalls of the excavation.

**Table 2:**
**Compliance Monitoring Soil Analyses**

| Category | Required Analytes | Analytical Method[d] | MDL[e] | Cleanup Level |
|---|---|---|---|---|
| Performance Monitoring of Excavation | GRO[a]<br>DRO[b]<br>HORO[c] | Field 418.1<br>Field 418.1<br>Field 418.1 | 10 mg/kg | 100 mg/kg<br>200 mg/kg<br>200 mg/kg |
| Post-Excavation Verification Monitoring | GRO<br>DRO<br>HORO | WTPH-G<br>WTPH-D<br>WTPH-418.1 Modified | 5 mg/kg<br>25 mg/kg<br>25 mg/kg | 100 mg/kg<br>200 mg/kg<br>200 mg/kg |
| Thermal Treatment Monitoring | HORO | Field 418.1<br>WTPH-418.1 Modified | 25 mg/kg<br>25 mg/kg | 200 mg/kg<br>200 mg/kg |

Note: [a]GRO: Gasoline-Range Organics
[b]DRO: Diesel-Range Organics
[c]HORO: Heavy Oil-Range Organics
[d]Other EPA- or Ecology-approved methods may be substituted for those listed above if detection limits and Quality Assurance levels are sufficient to satisfy the goals of this project.
[e]MDL = Method Detection Limit

4.2.2 Sampling Procedures

Samples collected from the excavation where no residual contamination is indicated will be discrete grab samples. Additional samples may be collected at the discretion of Enviros, if conditions or size of excavation warrant such action. Samples will be collected as described above in Section 4.1.2.

4.2.3 Sample Designation and Field Documentation

Designation and field documentation for samples collected for the purpose of verification shall be as described above in Section 4.1.3. In addition, all samples collected for analysis will follow chain-of-custody and sample preservation procedures described in Section 6.

4.2.4 Sample Analysis

Table 2 lists analytical methods, analytes, action levels, detection limits and sample containers required for post-excavation verification samples. These methods and analytes are consistent with the compounds of concern and cleanup levels specified in the Cleanup Action Plan.

## 4.3 Soil Treatment Performance and Verification Monitoring

The purpose of soil treatment performance and verification monitoring is to analyze thermally treated soils for residual TPH concentration before allowing their use as backfill material. The majority of these samples will be analyzed by Enviros IR Laboratory, with a portion of the samples (10%) split and analyzed by an independent laboratory to verify soil treatment.

4.3.1 Sample Frequency and Location

After treatment of contaminated soils by thermal desorption, samples will be collected from the treated soil and analyzed. On average, a minimum of one sample will be collected for each 500 tons (285 cubic yards) of soil treated. This is a reduction of the original frequency of one sample per 350 tons proposed. The reduction is proposed to account for the independent testing that TPS conducts as part of treatment verification of their process. Upon verification of attainment of cleanup levels, soils will be used to backfill open excavations and for regrading the site.

4.3.2 Sampling Procedures

Samples collected from thermally treated soil will be composite samples collected from two discrete locations for each 350 tons. Samples will be collected as described above in Section 4.1.2.

4.3.3 Sample Designation and Field Documentation

Designation and field documentation for samples collected for the purpose of verification shall be as described above in Section 4.1.3. In addition, all samples collected for analysis will follow chain-of-custody and sample preservation procedures described in Section 6.

4.3.4 Sample Analysis

Table 2 lists analytical methods, analytes, action levels, detection limits and sample containers required for soil treatment performance and verification monitoring samples. These methods and analytes are consistent with the compounds of concern and cleanup levels specified in the Cleanup Action Plan. Since heavy oil contains the most recalcitrant contaminants which are the limiting fraction to thermal treatment system performance, (they require the highest temperature to destroy), only Field 418.1 and WTPH-418.1 Modified analyses will be performed on treated soils.

## 5.0 GROUNDWATER TREATMENT SYSTEM PERFORMANCE AND CONFIRMATION MONITORING

### 5.1 Groundwater Treatment System Performance Monitoring

The groundwater treatment system performance monitoring will be performed during a pilot test which will have two purposes: 1) to characterize operating parameters of the vapor extraction/ air sparging system, and 2) to assess the efficacy of the system in gasoline vapor contaminant reduction. Characterization of the operational parameters will include stressing and monitoring of the hydraulics of the groundwater treatment system and monitoring the performance of a vapor phase bioreactor in treatment of gasoline vapor air emissions from the system. An internal combustion remediation engine will be operated and monitored simultaneously so that air emissions from the treatment unit are adequately controlled. System treatment efficiency will be assessed by collecting and evaluating groundwater and air emission concentration data during performance of the pilot test. The results and interpretation of the pilot test will be used as a basis for the final treatment system configuration for attainment of cleanup standards and goals as established in the CAP. Portions of this Section may require revision at a later time based on the results of the pilot test.

5.1.1 Sample Frequency and Location

Performance monitoring data will be collected on the groundwater treatment system as part of the four (4) week pilot test. Enviros proposes that the new wells installed (MW-1 through MW-4) prior to initiation of the pilot test be used as a measurement of the baseline condition. Since pilot test results and future compliance monitoring sample results will all be obtained from the new wells, using the same wells for the baseline analysis will minimize variability in results which are due to differences in well construction and location of the old compared to the new wells. Accordingly, Enviros proposes to collect four groundwater samples (one from each new well) prior to, and at the conclusion of the pilot test to assess system performance on reduction of groundwater contaminant concentrations.

Other treatment system operating parameters will be measured frequently (hourly to daily) at the start-up and first week of the pilot test when hydraulic testing is anticipated, including start and stop of the system. Operating parameter measurements will be obtained in piezometer clusters PC-1 and PC-2, the new monitoring wells (MW-1 through MW-4), and from gauges and metering instrumentation associated with the treatment system components. The operating parameters which will be measured are described below in Section 5.1.2.

In addition to groundwater testing and collection of system operating parameter data, air emission testing will be performed for the duration of the pilot test by using a PID. Analytical samples will also be obtained by collecting charcoal tube, syringe, or 5-liter air bag samples. A maximum of eight (8) analytical samples will be collected. Four (4) samples will be collect directly from the untreated air stream. These will be collected at the system start-up and at three time-points between the start-up and conclusion of the pilot test (estimated one sample per week). The remaining four (4) samples will be collected as two separate time-points (beginning and end of test) and in two locations (near the treatment system emission stacks/vents and in ambient background location).

5.1.2 Sampling Procedures

*Groundwater Sampling*

Samples will be collected following strict quality assurance and quality control measures so that accurate and reliable analytical results on groundwater quality are obtained. Water elevations will be measured and recorded to the nearest 0.01 feet for all the onsite wells. Wells will be purged of 3-5 well volumes of standing water prior to sample collection. To avoid excess volatile loss associated with rapidly recharging soil formations, each well will be hand bailed to permit its gradual refill. Specific conductance, temperature and pH measurements will be made after each purge volume to determine if groundwater quality conditions are stabilizing. Samples will be collected only after recharging groundwater has reached an observable steady-state of monitored physical parameters.

The bailers used for purging and sampling will be dedicated and disposable (Voss Technologies 1.66" x 36" or equivalent) to avoid contamination from improperly decontaminated reusable bailers. A sheet of dedicated plastic will be placed by the well so that the bailing line and bailer never contact the ground surface during bailing procedures (dirt and debris from the ground surface can introduce contaminants to the well). Groundwater samples will be collected by a bailing apparatus which will be lowered gently to the water surface to minimize disturbance and volatilization of the sample. Groundwater samples for gasoline constituents will be carefully poured into 40 milliliter glass vials with Teflon®-lined caps and septa. No field blank is

proposed since an unused, clean disposable bailer will be used. The laboratory will have its own internal precision and accuracy checks which will be reported with the analytical results provided. All samples will be delivered to the laboratory as described in Section 6.3.

*System Operating Parameters*

During pilot testing of the groundwater treatment system, the following system operating parameters will be monitored:

1) Water Level Measurements: Water elevations will be measured and recorded to the nearest 0.01 feet for all the onsite wells and groundwater piezometers PC-1 and PC-2.

2) Pressure Measurements: Pressure measurements will be obtained in shallow and deep air piezometers (PC-1 and PC-2), at vapor extraction well VEW-1, at air sparge well ASW-1, and in-line/upstream of the vapor phase bioreactor and the IC. Measurements will be collected using either portable or installed Magnehlic® or Capsuhelic® differential pressure gages (scale in inches of water: 0 to 1 inch, 1 to 10 inch, 0 to 100 inches, and 0 to 200 inches).

3) System Flow Rate Measurements: Flow rate measurements will be obtained within the air sparge and vapor extraction lines using installed rotometers (0 to 10 standard cubic feet per minute [scfm] and 0 to 70 scfm scales).

4) IC Measurements: In addition to flow rate and pressure readings, instrumentation information on the IC which will be recorded include: oil pressure, exhaust temperatures, voltage, power requirements and engine revolutions per minute. A PID will also be used to measure concentrations of volatile organic compounds (VOCs) at or near the exhaust.

5) Vapor Phase Bioreactor Measurements: In addition to flow rate and pressure readings, media moisture content, pressure drop across media, nutrient application rate, and water supply pressure and rate will be measure and recorded. A PID will also be used to measure concentrations of volatile organic compounds at the exhaust.

*Air Emissions*

During the initial testing period, Enviros will collect air samples from the system for laboratory analysis of benzene and gasoline range hydrocarbon concentrations. This sampling will occur simultaneously with PID monitoring of the same air stream and a correlation between the two methods will be determined. Analytical air sampling to document system performance will be conducted as follows:

1) 5-liter Bag Samples: Unused and dedicated 5-liter Tedlar® air sampling bags will be filled using an air sampling pump. Samples will be collected at or near the IC and vapor phase bioreactor air stacks. Stack exhaust air flow rate or process air stream flow rates will be measured concurrent with air sample collection.

2) Charcoal Tubes/Pads: Ambient air conditions will be determined over an 8-hour sampling period using calibrated air pumps and charcoal tubes or by passive adsorption to charcoal pads. Air samplers will be located a minimum of 15 feet from the immediate area of the treatment unit.

3) Syringe or 5-liter Bag Samples: A clean syringe or unused and dedicated 5-liter Tedlar® air sampling bag will be filled from the sampling valve at the top of vapor extraction well (VEW-1) head. The sample will be collected as follows: a) system is operating at an equilibrium flow rate (< 10% variability, minimum of 1 hour operation), b) system is shut-off and the flow field allowed to stabilize for 15 minutes, c) syringe or bag sample is collected from the interior of the vapor extraction well head.

5.1.3 Sample Designation and Field Documentation

Analytical samples collected from monitoring wells and air sampling locations for the purpose of performance monitoring will be assigned sample names which provide sufficient information, along with field notes, that their origin is easy to determine. Enviros will keep detailed field notes which provide the following information for each sample:

- Date sample collected; and
- Approximate locations of sample collection (with sketch if appropriate).

In addition, a chain of custody record will be completed for all samples (see Section 6.3, below). System operating parameter measurements will be recorded in field books and/or in formatted data sheets.

5.1.4 Sample Analysis

As specified in the CAP, the groundwater and air emission sampling parameters will be TPH as gasoline and benzene. For groundwater performance monitoring, it is anticipated that these parameters shall be suitable indicators for demonstrating the practicable cleanup of groundwater. Table 3 lists analytical methods, analytes, detection limits, and cleanup levels required for groundwater. These methods and analytes are consistent with the compounds of concern and cleanup levels specified in the CAP.

## 5.2 Groundwater Treatment System Verification/Confirmation Monitoring

The groundwater treatment system verification/confirmation monitoring will be performed to evaluate the long-term efficacy of the treatment system in reducing groundwater gasoline contaminant concentrations and achieving the cleanup standards for the Metro South Dearborn site as set forth in the CAP. The requirements of long-term monitoring for the final treatment system configuration may need revision at a later time based on the results of the pilot test.

5.2.1 Sample Frequency and Location

As stipulated in the Consent Decree, Enviros proposes to sample groundwater monitoring wells MW-1 through MW-4 ( four samples per event) on a semi-annual basis for a maximum period of 2.5 years or until attainment of practicable cleanup of groundwater. These monitoring points are located approximately parallel the south and west property lines of the South Dearborn Facility on the east parcel as required by the Consent Decree.

**Table 3:**
**Compliance Monitoring Groundwater and Air Emission Analyses**

| Category | Required Analytes | Analytical Method[a] | MDL[b] | Cleanup Level |
|---|---|---|---|---|
| Groundwater Performance Monitoring | Gasoline<br>Benzene | WTPH-G<br>EPA Method 8020 | 100 µg/l<br>1 µg/l | 1000 µg/l<br>5 µg/l |
| Air Emission Performance Monitoring | Gasoline<br>Benzene | NIOSH Method #1500 and #1501 | 1 µg[c]<br>1 µg | N/A<br>N/A |
| Groundwater Confirmation Monitoring | Gasoline<br>Benzene<br>Semi-Volatiles<br>Volatiles | WTPH-G<br>EPA Method 8020<br>EPA Method 8270/610<br>EPA Method 8260 | 100 µg/l<br>1 µg/l<br>Variable<br>Variable | 1000 µg/l<br>5 µg/l<br>N/A<br>N/A |
| Air Emission Confirmation Monitoring | Gasoline<br>Benzene | NIOSH Method #1500 and #1501 | 1 µg<br>1 µg | N/A<br>N/A |

Note: [a]Other EPA, NIOSH-or Ecology-approved methods may be substituted for those listed above if detection limits and Quality Assurance levels are sufficient to satisfy the goals of this project.
[b]MDL = Method Detection Limit
[c]Laboratory contaminant mass must be converted to concentration based on total air sample volume and/or measured flow rate

Analytical testing of air emissions will also be performed on a semi-annual basis. Two samples will be collected per sampling event. One sample will be collected at the vapor extraction well (VEW-1) to assess treatment effectiveness and the other in the general area of the treatment system to test for fugitive or untreated gas emissions.

Other treatment system operating parameters will be measured bi-monthly, depending on the observed variability in system performance. System operating parameter measurements will be obtained in piezometer clusters PC-1 and PC-2 (and any additional clusters installed after the pilot test), the new monitoring wells (MW-1 through MW-4), and from gauges and metering instrumentation associated with the treatment system components.

5.2.2 Sampling Procedures

The sampling procedures shall be as described above in Section 5.1.2 except that IC instrumentation measurements will no longer be collected since it is anticipated that this component of the pilot test treatment system will no longer be needed.

5.2.3 Sample Designation and Field Documentation

The sample designation and field documentation shall be as described above in Section 5.1.3.

5.2.4 Sample Analysis

As specified in the CAP, the groundwater and air emission sampling parameters will be TPH as gasoline and benzene. For groundwater confirmation monitoring, it is anticipated that these

parameters shall be suitable indicators of achieving practicable cleanup of groundwater. In addition, semi-volatile and volatile organic analyses of groundwater (EPA Methods 8270 and 8260, respectively) will be performed on a one-time basis as stipulated in the CAP since such contaminants have been detected in some onsite wells. Table 3 lists analytical methods, analytes, detection limits, and cleanup levels required for groundwater and air emission standards. These methods and analytes are consistent with the compounds of concern and cleanup levels specified in the CAP.

## 6.0 FIELD QA/QC SAMPLING AND ANALYSIS PROCEDURES

### 6.1 Field QA/QC Sampling

Approximately 10% of all soil samples collected for Field 418.1 analysis will be collected in duplicate. Duplicate samples will be collected from the same location, placed in separate jars and given different sample numbers. Duplicate samples will be analyzed both by Field 418.1 and by an independent laboratory. Analyses performed by the independent lab shall include WTPH-418.1 Modified, WTPH-D, WTPH-G and benzene.

### 6.2 Equipment Decontamination

Field equipment that may contact contaminated soil should be decontaminated prior to use and between each sampling event. The following decontamination procedure (or equivalent) will be used:

- Rinse with distilled water;
- Wash in a solution of laboratory detergent and distilled water;
- Rinse with distilled water;
- Rinse with a 10% methanol;
- Rinse with distilled water;
- Air-dry; and
- Protect and cover decontaminated equipment until next use.

### 6.3 Sample Custody and Transport

All samples will be transported to the analytical laboratory within 24 hours of sampling. All samples will be packaged for shipment in iced coolers. A sufficient amount of ice will be used in each cooler to maintain sample temperatures at approximately 4° C during transport. All ice used in coolers will be packaged in leak-proof containers or bags.

A chain-of-custody record will be completed to accompany all samples from the time of collection to analysis at the laboratory. At a minimum, the following information will be provided on the chain-of-custody record:

- Project name and number;
- Project manager;
- Sampler's name;
- Sample number;
- Date of sample collection;
- Requested analyses and turnaround times; and
- Signatures of all persons having custody during shipment.

In addition, the laboratory identification number(s) will be entered on the chain-of-custody record by the laboratory sample custodian when the samples arrive at the laboratory.

The chain-of-custody record will be completed in ink. Any required corrections to the information provided on the chain-of-custody record will be made by drawing a line through the erroneous information, entering the correct information, and initialing and dating the change. The erroneous information should remain legible.

## 7.0 LABORATORY QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC) PROCEDURES

This section addresses the required QA/QC procedures associated with the laboratory analysis of samples from progress and verification monitoring activities.

### 7.1 Quality Assurance Objectives

The quality assurance objective of this project is to develop and implement procedures that will provide data of known and appropriate quality. The applicable quality control procedures, quantitative target limits, and levels of effort for assessing data quality are dictated by intended use of the data and the nature of the analytical methods. For this project, the purpose of the chemical analyses is to confirm attainment of the cleanup levels established in the CAP.

Data quality is assessed by representativeness, comparability, accuracy, precision, and completeness. Definitions of these parameters, the applicable procedures, and the levels of effort are described below.

#### 7.1.1 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the materials sampled. Sampling plan design, sampling techniques, and sample handling protocols have been developed and are discussed in Section 5 and Section 6. The proposed documentation will establish that protocols have been followed and that sample identification and integrity have been assured. In order to assess the potential for laboratory contamination, laboratory method blanks will be run at an appropriate frequency, as recommended in Ecology or EPA guidance and standard laboratory practice.

#### 7.1.2 Comparability

Comparability expresses the confidence with which one set of data can be compared to another. Comparability of the data will be maintained by using Ecology- or EPA-defined procedures and through the use of consistent methods and units.

#### 7.1.3 Accuracy

Accuracy is an assessment of the closeness of the measured value to the true value. Accuracy measurements will be carried out in accordance with Ecology and EPA guidance and standard laboratory practice.

The accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. For organic analytes measured by chromatography, two types of recoveries are typically measured: matrix spike recoveries and surrogate spike recoveries. For a matrix spike, known amounts of standard compounds identical to the compounds present in the sample of interest are added to the sample For a surrogate spike, the standards are chemically similar but not identical to the compounds being analyzed in the fraction. The purpose of the surrogate spike is to provide quality control on every sample by constantly monitoring for unusual matrix effects and gross sample processing errors.

7.1.4 Precision

Precision is a measure of the spread of the data when more than one measurement is taken on the same sample. For duplicate measurements, precision can be expressed as the relative percent difference (RPD). Target precision levels have been established by Ecology and EPA and are available for comparison with those achieved by the laboratory.

7.1.5 Completeness

Completeness is a measure of the amount of valid data (i.e., the portion of the data which meets established QA/QC guidelines, as determined by an independent data validation) obtained form the analytical measurement system and the complete implementation of defined field procedures. The target completeness objective for this project will be 90%.

### 7.2 Analytical Methods

Samples will be analyzed for chemical parameters using the methods listed in Section 4 and Section 5 and Tables 2 and 3. Standard Ecology and EPA methodologies and quality control limits will be used for all analyses (unless specified otherwise).

## 8.0 DATA SUMMARY AND EVALUATION

### 8.1 Data Validation

Enviros will review all analytical data to assure that QA/QC procedures are being properly implemented. Enviros will determine whether QC runs meet the frequency requirements and whether the QC data is within the QC limits. The data will include, at a minimum, the following:

- Holding times;
- Calibration data;
- Accuracy and precision data;
- Blank data; and
- Compound identification criteria as applicable (retention time windows, etc.).

### 8.2 Data Evaluation

In general, all data will be evaluated using procedures recommended by Ecology in *Statistical Guidance for Ecology Site Managers (1992 and Supplements)* and *Guidance on Sampling and Data Analysis Methods (January, 1995).* Specifically, underlying probability distribution tests will be performed, data comparisons of sample splits will be performed, and 95% upper confidence limits (UCLs) about the true population mean will be calculated and compared to the

cleanup levels indicated in Tables 2 and 3 to verify that cleanup objectives have been met. Total sample numbers, frequency of sampling and analytical parameters to be tested are summarized below in Tables 4 and 5.

8.2.1 Underlying Distribution Analysis

Prior to performing any statistical procedures or comparisons, the data sets will be examined for their underlying probability distributions. In order to be valid, many statistical tests and calculations require that the data approximate a normal (or Gaussian) probability distribution. To achieve this condition, environmental data frequently require transformation to a logarithmic scale followed by special calculation procedures to determine the mean and to estimate data variability. The underlying distribution analysis will be performed to evaluate the need for data transformation and to determine the most appropriate methods for estimating sample average and variance. These statistics are needed in evaluating the attainment of cleanup goals as stipulated in the CAP. Details of the underlying distribution analysis are provided in the Appendix.

8.2.2 Data Comparisons to Evaluate Onsite Laboratory Performance

A data analysis will be performed to evaluate the precision and accuracy of data generated by the Enviros IR Laboratory compared to a base laboratory performing identical TPH and other analyses. Ten percent (10%) sample splits will be obtained randomly from samples collected during the remediation project. The premise of the statistical comparisons will be to test for significant difference between the Enviros IR Laboratory and base laboratory data sets and thereby verify accuracy and precision of the Enviros IR Laboratory.

Parametric and/or nonparametric (distribution-free) statistical tests will be used to compare data sets which will be distinguished by laboratory. Selection of the analysis method will be governed by the underlying probability distribution tests described above.

Data sets determined to be normal will be tested by simple parametric student t-tests using a 5% significance level. Non-parametric tests that will be considered include the Mann-Whitney test for sample sizes of 10 or less samples and the Wilcoxon Rank Sum test for sample sizes greater than 10. The significance level for all statistical tests shall be 5%.

8.2.3 Cleanup Verification Using 95% UCLs

Enviros proposes to calculate 95% UCLs for the remaining contaminant concentrations of treated media from the South Dearborn Facility. The 95% UCL is a combination of an average (true population mean) sample concentration and an uncertainty term which measures the accuracy or variability of the sampling results. The 95% UCL is a single numeric value expressed as a concentration which will be compared directly to the cleanup standards stipulated in the CAP and which are summarized in Tables 2 and 3 of this Compliance Monitoring Plan. Verification will be demonstrated if the 95% UCL is below the applicable MTCA cleanup standard.

In addition, the data used to calculate UCLs will conform to the following criteria stipulated in WAC 173-360-708 (11)(d):

> No single sample concentration can be more than twice the cleanup level, and
>
> Less than 10% of the samples can exceed the cleanup level.

**Table 4. Sampling Frequencies**

| Category | Proposed Minimum Sampling Frequency |
|---|---|
| **Soils** | |
| Stockpile | 1 sample/25 $yd^3$ or 35 tons when PID results inconclusive |
| Post-Excavation | 1 sample/350 tons Contaminated Soil |
| Thermal Performance | 1 samples/500 tons Contaminated Soil |
| **Groundwater and Air** | |
| Long-Term Groundwater Monitoring | Before and after Pilot test, then Semi-Annual thereafter |
| PID Monitoring of Air Emissions | Bimonthly |

*Treated and Remaining Soils*

Enviros proposes to calculate separate 95% UCLs for each discrete soil excavation area (Excavation "B" etc.) to estimate remaining concentrations of WTPH-G and benzene, WTPH-D and WTPH-418.1 Modified, as appropriate to each excavation. These calculated concentrations will then be compared to cleanup standards specified in the CAP to determine if the soil cleanup has been achieved or if elevated contaminant concentrations remain. The 95% UCLs will serve as the final concentration estimate either indicating completion of remediation or the need for institutional controls in areas where further excavation is impractical.

The same procedure will be followed for evaluation of the efficacy of thermal treatment of contaminated soils. A 95% UCL will be calculated for WTPH-418.1 Modified and Field 418.1. These UCLs will be compared to cleanup standards specified in the CAP.

*Groundwater Concentrations*

Enviros proposes to calculate 95% UCLs for WTPH-G and benzene concentrations for each round of ground water sampling data to evaluate site-wide variations in contaminant concentrations. In addition, 95% UCLs shall be calculated for each well to evaluate separate compliance point groundwater concentrations. These 95% UCLs shall be compared to cleanup standards specified in the CAP and Consent Decree. Groundwater cleanup shall be deemed complete when the cleanup standard for WTPH-G and benzene have been achieved or the practicable extent of cleanup has been demonstrated. The practicable extent of cleanup shall be indicated by the residual groundwater concentration corresponding to the break in the slope of a concentration/time or cost/benefit curve representing diminishing contaminant reduction.

**Table 5. Total Number of Samples**

| Parameter | Estimated Total Number of Samples | | |
|---|---|---|---|
| | Performance Monitoring | Verification Monitoring | Compliance Monitoring |
| **Soils** | | | |
| PID/Visual | >400 | NA | NA |
| Field 418.1* | 230 | NA | NA |
| Independent Lab | 23 (10% splits) | 28 | NA |
| WTPH-HCID | 5 | NA | NA |
| **Groundwater** | | | |
| WTPH-G | 8 | NA | 16 |
| Benzene | 8 | NA | 16 |
| Volatile Organics | 0 | NA | 4 |
| Semi-Volatile Organics | 0 | NA | 4 |
| **Air Emissions** | | | |
| WTPH-G | 8 | NA | 8 |
| Benzene | 8 | NA | 8 |
| PID Measurements | when monitoring | | |

NA=Not Applicable
*Field 418.1 will consist of a modification of Ecology Method WTPH-418.1 Modified. The field method will be modified to minimize loss of volatiles and allow for rapid turnaround.

*Air Emission Concentrations*

Enviros proposes to qualitatively evaluate WTPH-G and benzene concentrations at each timepoint that air emission sampling data is collected. The data will also be analyzed graphically by plotting a curve of residual air stream concentrations versus time to assess the asymptotic reduction in contaminants. Air emission data and groundwater data will be evaluated collectively to determine if cleanup is complete.

8.2.4 Data Presentation

All data generated as part of the remediation will ultimately be summarized in a Final Cleanup Report presented to Metro and Ecology according to reporting requirements stipulated in the CAP and Consent Decree.

Interim reports on the pilot test results, soil remediation, and semi-annual groundwater sampling and treatment system monitoring results may also be prepared. In general, all data provided as part of the compliance monitoring plan will be tabulated and graphically plotted on site maps.

Statistical calculation examples and results will be provided as well as all laboratory reports and other QA/QC documentation.

Please call if you have any questions regarding this Final Compliance Monitoring Plan. Revisions of this document based on conversations with Ecology and the results of the pilot test are possible.

This document was prepared by:

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## References


Remedial Investigation: Final Report, Volume I (revised) and Volume II (Appendices). Second Phase of Site Characterization of the Metro South Dearborn Facility, Seattle, Washington, Enviros Incorporated, October 22, 1993 and August 8, 1992 (Volume II).

Final Report (revised). Human Health Risk Assessment and Feasibility Study of the Metro South Dearborn Facility, Seattle, Washington, Enviros Incorporated, October 22, 1993.

Cleanup Action Plan, South Dearborn Facility, Seattle, Washington, Enviros Incorporated, November 3, 1994.

Gilbert, Richard O. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold. 1987.

Devore, Jay L. Probability and Statistics for Engineering and the Sciences. Second Edition. Brooks/ Cole Publishing Company. 1987.

Kreyszig, Erwin. Sixth Edition Advanced Engineering Mathematics. John Wiley & Sons, Inc. 1988

Washington Department of Ecology. Guidance on Sampling and Data Analysis Methods. January 1995.

Washington Department of Ecology. Statistical Guidance for Ecology Site Managers. August 1992.

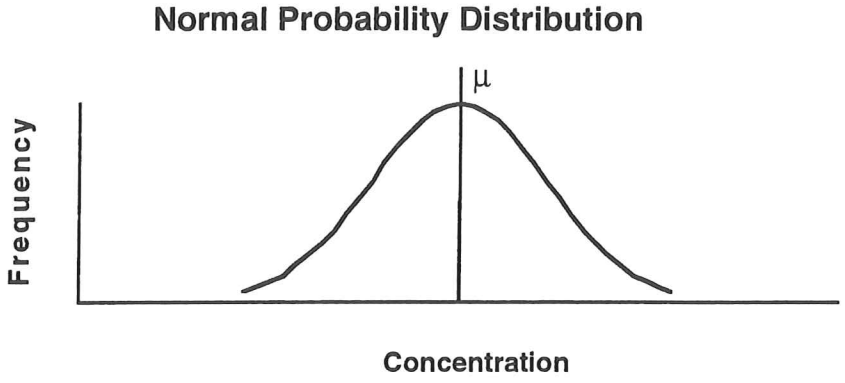
## APPENDIX FOR STATISTICAL PROCEDURES

## A-1. Underlying Probability Distribution Testing

In order to be valid, many statistical tests require that the data approximate a normal (or Gaussian) probability distribution. Normally distributed data exhibit a bell-shaped curve symmetrical with the population mean ($\mu$) as shown in Figure A-1.

Environmental pollution monitoring data however, are typically skewed (not symmetric with respect to a vertical line) and typically follow lognormal and exponential probability distributions (Gilbert, 1987). A positively skewed distribution is shown in Figure A-2.

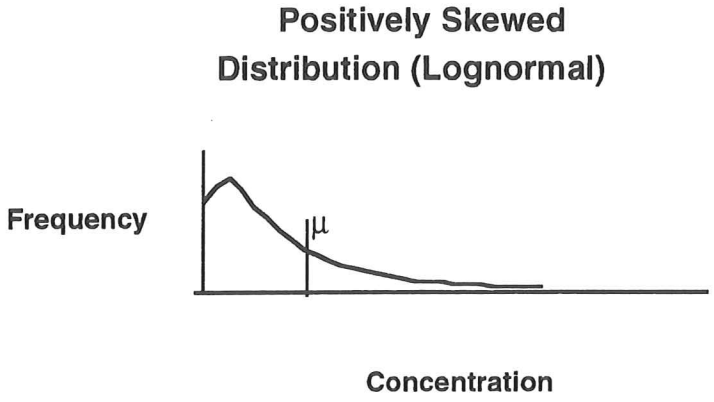
**Figure A-1. Typical Normal Distribution**




Statistical procedures need to account for the underlying probability distribution. That is, statistical procedures performed on normally distributed data cannot be applied to lognormally distributed data unless the sample size is very large or the data is transformed to yield a normal distribution. Lognormally distributed data is transformed to normal data by calculating the natural logarithm (base e) of each of the data points.

Distribution testing will be performed to asses whether the data followed a normal or lognormal distribution and to validate the need or no need for data transformation prior to performing subsequent statistical analyses.

**Figure A-2. Skewed Distribution**




The test procedure involves ordering sample concentration values in ppm and ln(ppm) in ascending order (order statistic) and assigning the concentrations a rank and corresponding probability quantile. The probability quantiles are calculated as follows:

$$\text{probability} = \left(\frac{i - 0.5}{n}\right)$$

where: i = rank
n = number of samples

An x-y quantile-quantile plot is then determined by assessing the linearity of the plot. The plot having the more linear relationship between concentration (or transformed concentration) and probability of occurrence represents the best fit underlying distribution.

## A-2 Upper Confidence Limit Calculation

*Upper confidence levels for normally distributed data*

The sample mean determined from a set of samples from a normal distribution provides a point estimate of the population mean. Confidence intervals are based on the distribution of the sample mean with respect to the variance. The sample mean follows a Student's t distribution. The following relationship was used to calculate the 95% UCL for normally distributed soil and groundwater data:

$$UCL = \bar{x} - t_{1-\alpha,n-1}\frac{s}{\sqrt{n}}$$

where: $\bar{x}$ = sample mean
s = sample standard deviation
n = number of samples
t = t statistic based on a one sided $\alpha$ of 0.05 and n-1 degrees of freedom

*Upper confidence levels for lognormally distributed data*

The procedure used to calculate the 95% UCL for lognormally distributed data is that recommended in Ecology's *Statistical Guidance for Ecology Site Managers* The procedure uses statistics calculated from the $\log_e$ -transformed sample data from a lognormal distribution, as well as a parameter, H, determined from tabled values and based on the standard deviation of the sample set and degrees of freedom. The following equation was used to calculate the 95% UCL for lognormally distributed soil data:

$$UCL = \exp(\bar{y} + 0.5s_y + \frac{s_y H_{1-\alpha}}{\sqrt{n-1}})$$

where: exp= e raised to the indicated power
$\bar{y}$ = mean of transformed data
$s_y^2$ = standard deviation of transformed data
H = statistic defined by Land (1972, 1975)
$\alpha$ = significance level (0.5)