Quality Assurance Plan for Field Screening and Disposal Characterization for Petroleum Contamination

for

Washington State Department of Transportation

October 26, 2012

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0180-302-00, Task 100

October 26, 2012

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INTRODUCTION

The purpose of this document is to provide guidance for Washington State Department of Transportation (WSDOT) staff on the typical soil and water sampling methodology to characterize soil for disposal and/or reuse at petroleum-contaminated sites.

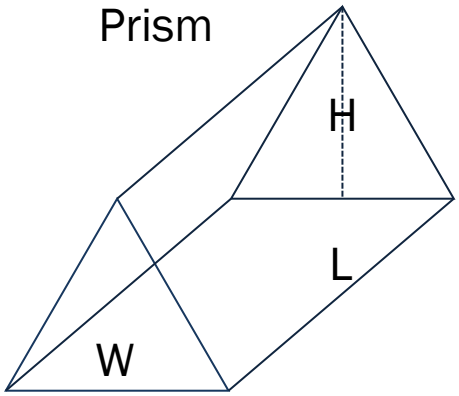
SOIL SAMPLING

Determining the Correct Number of Soil Samples

The number of samples necessary to characterize a soil pile will vary depending on site-specific conditions and the local health department or disposal site requirements. This section provides guidance for typical requirements. The hazardous materials specialist should contact the waste disposal facility prior to completing sampling to confirm sampling requirements.

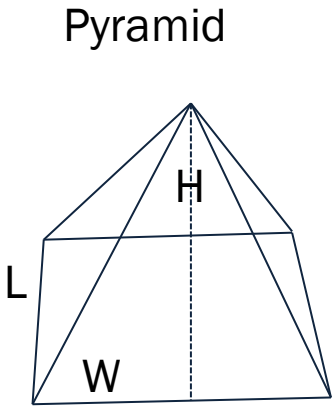
Soil Volume Calculation

The volume of soil can be calculated based on the configuration and size of the stockpile. Soil is generally stockpiled as a pyramid (point at top) or a prism (equal height across the top).



W = width
H = height
L = length

Volume of Prism = (L x W x H)/2



W = width
H = height
L = length

Volume of Pyramid = (L x W x H)/3

Number of Samples to Collect

The Washington State Department of Ecology (Ecology) provides recommendations for the number of samples to adequately characterize soil for disposal based on the volume of soil. The recommendations are summarized in Table 1.

TABLE 1. TYPICAL NUMBER OF SAMPLES TO ADEQUATELY CHARACTERIZE SOIL STOCKPILES

Cubic Yards of Soil	Number of Samples for Chemical Analysis
0 to 100	3
101 to 500	5
501 to 1,000	7
1,001 to 2,000	10
>2,000	10 + 1 for each additional 500 cubic yards

Source: https://fortress.wa.gov/ecy/publications/publications/1009057.pdf

Field Screening

Field screening results are used as a general guideline to assess areas of possible petroleum-related contamination. The field screening methods used include: 1) visual screening, 2) water sheen screening and 3) headspace vapor screening using a Photo Ionization Detector (PID) calibrated to isobutylene.

Field screening results are site specific. The effectiveness of field screening varies with temperature, moisture content, organic content, soil type and type and age of contaminant. The presence or absence of a sheen or headspace vapors does not necessarily indicate the presence or absence of petroleum hydrocarbons.

Visual

Visual screening consists of observing soil for stains indicative of petroleum-related contamination. Visual screening is generally more effective when contamination is related to heavy petroleum hydrocarbons or the hydrocarbon concentrations are high.

Sheen

Water sheen screening involves placing soil in a pan of water and observing the water surface for signs of sheen. Sheen screening may detect both volatile and nonvolatile petroleum hydrocarbons, but is more effective at detecting middle distillate (diesel) and heavy petroleum hydrocarbons. Sheens observed are classified as follows:

No Sheen (NS)	No visible sheen on the water surface.
Slight Sheen (SS)	Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly. Natural organic matter in the soil may produce a slight sheen.
Moderate Sheen (MS)	Light to heavy sheen; may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on the water surface.
Heavy Sheen (HS)	Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen.

Note: False positive results may be generated by the presence of decaying organic matter and iron bacteria. These sheens, unlike oil sheens, can typically be broken up when agitated or disturbed.

Headspace Vapor Analysis

Headspace vapor screening targets volatile petroleum hydrocarbon compounds (gasoline). Headspace vapor screening involves placing a soil sample in a sealed container and measuring the vapors with an organic vapor detector. WSDOT typically uses a MiniRae 2000 PID for headspace vapor screening.

The process for measuring head space vapors consists of the following:

- Place approximately two cups of soil in a plastic bag.
- Seal the bag and shake the soil to volatilize the contaminants in the soil.
- Insert the probe of the instrument inside the back and measure the vapor concentration. Care should be taken to not let air escape from the bag while inserting the PID and during stabilization. The maximum PID measurement should be recorded.

CALIBRATION OF EQUIPMENT

Calibration and calibration checks facilitate accurate and reliable field measurements. At the start of the field day, the PID should be calibrated per manufacturer's instructions using isobutylene gas. The PID should be checked and recalibrated as necessary with isobutylene gas during field activities if anomalous results are occurring. The calibration instructions for the MiniRae 2000 PID are included in Appendix A. Water vapor and high humidity can suppress the response to organic vapors. If the PID is providing anomalous results and not calibrating correctly, it may assist the functioning of the equipment to place it in a running vehicle with the defrost running.

Calibration records specific to each item of equipment should be maintained. Calibration or operational checks should be documented in field or laboratory notebooks. The equipment serial number or other ID number should be included in all types of calibration records so that the calibration history can be readily followed.

Sampling Methodology

Sample Containers and Labeling

Required sample containers may be different from different laboratories. The typical containers required for petroleum-related constituents are summarized on Table 2. Confirmation of sample container requirements should be verified with the laboratory.

Soil stockpile(s) should be identified in consecutive order and describe the source of the material. An example identification system labels the first stockpile as "STK-A-Foundation-1", where STK- is stockpile and -A identifies alphabetically the consecutive order of the stockpile(s), –Foundation describes the location the soil was sourced, and -1 describes the first soil sample collected from stockpile A.

The hazardous material specialist shall keep documentation of the soil samples collected and approximate volume for future reference.

TABLE 2. TYPICAL SOIL SAMPLE CONTAINERS – ONSITE ENVIRONMENTAL, INC.

Analysis	Method	Holding Time	Containers Per One Soil Sample
Fuel Station Sites			
Gasoline Range Organics with BTEX	NWTPH-Gx/ EPA 8021B per Method 5035A	14 days	1 VOA vial (40mL)s Without stir bars, preserved with 5 mL of Methanol [1 & 2] 1 four ounce jar for dry weight
Diesel & Heavy Oil Range Organics	NWTPH-Dx	14 days	8 oz Jar
RCRA 8 or MTCA 5 Metals or Total Lead	EPA6020/7470 or EPA 6020	28 days	
Volatile Organic Compounds (includes napthalenes)	EPA 8260B	14 days	2 VOA vial (40mL)s Without stir bars, preserved with 5 mL Methanol [1 & 2] 2 VOA vial (40mL)s With stir bars, preserved with 5 mL Sodium bisulfate [1 & 2] 1 four ounce jar for dry weight[3]
Semi Volatile Organic Compounds (includes PAHs and naphthalenes) [3]	EPA8270 / SIM	14 days	
PCBs	EPA 8082	None	8 oz Jar
David Baumeister/dbaumeister@onsite-env.com/(425)883-3881			
Overnight Mail to: OnSite Environmental, Inc., 14648 NE 95th Street, Redmond, WA 98052			

Notes:

[1] Methanol preserved VOAs should not be stored longer than 6 months. Its good practice to recycle them every three months because eventually the preservative evaporates (depending on how they are stored) which can lead to results with higher concentrations. Samples do not have to be preserved with methanol if samples are submitted to the lab within 48 hours. However, we prefer to use methanol in order to extend the holding time from 48 hours to 14 days to allow for overnight mailing and/or extended field work.

[2] For 5 milliliters of methanol, collect 5 grams of soil. It is not critical to be 100% accurate, but it is preferred for soil to be at least 5 grams. Less than 4.5 grams or too greater than 6 grams soil can present issues during chemical analysis. The EPA Method 5035 sampling handle and syringe ensures that the proper amount of soil is collected.

[3] The 4 oz jar is necessary for dry weight analysis.

Sample Collection

The stockpile should be divided into equal sections based on the number of samples to be collected. Soil samples should be collected from the stockpiles at a frequency as described above or as specified by the potential end use disposal facility. Three-point composite grab samples should be collected with hand tools 6 to 12 inches beneath the surface of the stockpile. The material should be collected using a clean, stainless steel spoon/trowel or directly using a clean, gloved hand and placed in a clean stainless steel bowl or plastic bag. The samples should be placed in pre-cleaned, previously unused sample jars supplied by a subcontracted laboratory after the soil has been homogenized. The samples should be placed in a cooler on ice for transport to the laboratory.

SW-846 METHOD 5035A

The EPA document "Test Methods for Evaluating Solid Waste, SW-846," describes a closed-system purge-and-trap process for the collection, preparation and analysis of volatile organic compounds (VOCs) including gasoline-range petroleum hydrocarbon in soils, sediments, and solid waste. This closed-system purge-and-trap process is known as Method 5035A

Method 5035A provides details regarding the three options available for sample collection. Each option requires different sample containers and volume of soil. The individual laboratory may prefer a specific option. The WSDOT hazardous material specialist should coordinate with the individual laboratory to evaluate the preferred method for each site. The options are as follows:

- Option 1 - Lab Preservation

  Sample collection will require the following:

  - Two pre-weighed vials containing a small magnetic stir bar for low level analysis.
  - One pre-weighed vial for medium-high level analysis.
  - One 4-ounce jar for percent total solids determination.
  - Filled vials need to be frozen to between –7°C and –20°C within 48 hours of sample collection. Store samples at 4°C prior to initiating freezing.

- Option 2 – Field Preservation

  Sample collection and preservation in the field will require the following:

  - Two sodium bisulfate preserved, pre-weighed vials for low level analysis.
  - One methanol preserved, pre-weighed vial for medium level analysis.
  - One 4-ounce jar for percent total solids determination.
  - Methanol is flammable. If samples will be shipped to the laboratory via couriers such as, UPS or Federal Express, DOT labeling requirements must be met. Contact the lab for additional information concerning labeling requirements.

- Option 3 – EncoreTM Samplers

  Sample collection using EnCoreTM samplers will require:

  - Two EnCoreTM 5g samplers for low level analysis.

    One1 EnCoreTM 5g sampler for medium level analysis.
  - One 4-ounce jar for percent total solids determination.
  - T-handle for sampling.

WATER SAMPLING

Sampling Frequency

Water samples are typically collected from the first batch of water generated from a single location (i.e., foundation or trench). Additional water samples are typically not necessary unless conditions change or if required by the disposal facility.

Sampling Methodology

Sample Containers and Labeling

Required sample containers may be different from different laboratories. The typical containers required for petroleum-related constituents are summarized on Table 3. Confirmation of sample container requirements should be verified with the laboratory.

Water tanks should be identified in consecutive order and describe the source of the material. An example identification system labels the first tank as "W-A-Foundation", where W is for water and -A identifies alphabetically the consecutive order of the tank(s) and –Foundation describes the location the water was sourced.

The hazardous material specialist shall keep documentation of the water samples collected and approximate volume for future reference.

TABLE 3. TYPICAL WATER SAMPLE CONTAINERS – ONSITE ENVIRONMENTAL, INC.

Analysis	Method	Holding Time	Containers Per One Water Sample
Fuel Station Sites			
Gasoline Range Organics with BTEX	NWTPH-Gx/ EPA 8021B	14 days	3 VOA vials (40mLs) HCL preserved
Diesel & Heavy Oil Range Organics	NWTPH-Dx	14 days	2 (0.5L Amber glass) with HCl
RCRA 8 or MTCA 5 Meals or Total Lead	EPA6020/7470 or EPA 6010	28 days = Mercury 6 months = other metals	Total Metals - 1 HDPE (0.5L poly) preserved with HNO3 and not filtered in the field Dissolved Metals - Field Filtered - 1 HDPE (0.5L poly) preserved with HNO3 Not field filtered - 1 HDPE (0.5L poly)
Volatile Organic Compounds	EPA 8260B	14 days	5 VOA vials (40mL)s HCL preserved
Semi Volatile Organic Compounds (includes PAHs and naphthalenes)	EPA8270 / SIM	7 days	2 (1L Amber glass) unpreserved
PCBs	EPA 8082	none	2 (1L Amber glass) unpreserved
[2] VOA containers should be filled carefully to minimize turbulence and aeration, and must be absolutely free of bubbles, with no headspace. Do not to overfill the container and loose preservative. Maintain in a cooler at 4o C for the duration of the sampling and transportation period.			
David Baumeister/dbaumeister@onsite-env.com/(425)883-3881			
Overnight Mail to: OnSite Environmental, Inc., 14648 NE 95th Street, Redmond, WA 98052			

Sample Collection

Water will likely be captured and stored in temporary storage tanks or other portable containment structures. A sample should be collected from a discharge port on the tank or from within the tank or containment structure using a bailer. The bailers should be dropped to within 1 foot of the bottom of the tank.

The samples should be placed in pre-cleaned, previously unused sample containers supplied by a subcontracted laboratory. The samples should be labeled and placed in a cooler on ice for transport to the laboratory. Sample handling should follow appropriate chain-of-custody (COC) procedures from sample collection through analysis.

VOCs/Gasoline-Range Petroleum Hydrocarbons

Water samples for VOCs and gasoline-range petroleum hydrocarbons are typically collected into 40-milliliter glass vials with a preservative. The following procedure should be followed for collecting volatile water samples to prevent the loss of VOCs.

- Open sample vial. Tip the vial slightly so that the water flows down the sidewall of the container.
- Bring vial to an upright position as it fills. Fill just to the point of overflowing; there should be a "reverse" meniscus, or a small dome of water just above the top of the bottle.
- Seal the vial so that no air bubbles are trapped. Make sure the Teflon side of the liner is in contact with the water. The Teflon side appears more white and shiny than the backside of the liner.
- Turn the vial upside down and gently tap the cap on a solid surface. If any bubbles are evident, open the vial and add few more drops of water. If bubbles are still evident, dispose of the vial and start the process again with a new clean bottle.

CHEMICAL ANALYSIS

The soil and water samples should be submitted for chemical analysis based on the chemicals of concern identified from previous historical and subsurface investigations. Table 4 describes typical petroleum related sources and chemical analysis required under MTCA rule Table 830-1. The chemical analysis shown in Table 4 is intended to cover the requirements for disposal at RCRA Subtitle D landfill, inert waste pit site or reuse on the project. Initial analysis may be required for disposal at a RCRA Subtitle D landfill if total concentrations exceed the values shown in Table 5. If the source of the potential contamination is unknown, the WSDOT hazardous materials specialist should coordinate with disposal facility to evaluate chemical analysis required for disposal. Ecology guidance regarding reuse of petroleum-impacted soil is included in Appendix B.

TABLE 4

CATEGORIES OF PETROLEUM PRODUCTS AND TYPICAL CHEMICAL ANALYSIS REQUIRED FOR DISPOSAL

QUALITY ASSURANCE PLAN FOR FIELD SCREENING AND DISPOSAL CHARACTERIZATION FOR PETROLEUM CONTAMINATION

	NWTPH-GXx	NWTPH-Dx	VOCs by EPA Method 8260 or 8021							PAHs by EPA Method 8270 Sim	Metals by EPA Method 6000/7000 Series		EPA Method 8082	Chemical Specific
Categories of Petroleum Products	Gasoline-Range Petroleum Hydrocarbons	Diesel- and Oil-Range Petroleum Hydrocarbons	BTEX	MTBE	EDB	EDC	Naphthalenes	HVOCS	Other Fuel Additives and Blending Compounds [1]	cPAHs	Lead[2]	Cadmium, Chromium, Nickel and Zinc	PCBs	Other Site Contaminants
Gasoline-Range Petroleum Hydrocarbons Automotive Gasoline Aviation Gasoline Automotive Racing Fuel Mineral Spirits Naptha Stoddard Solvents	X		X	X	X	X	X				X			X
Middle Distillates/Diesel-Range Petroleum Hydrocarbons Diesel No. 1 Kerosene Diesel No. 2 Diesel and Biodiesel Mixtures Home Heating Oil Jet Fuel Light Oil		X	X				X							X
Heavy Oil-Range Petroleum Hydrocarbons Bunker C No. 4 Fuel Oil No. 5 Fuel Oil No. 6 Fuel Oil Products included under waste oil prior to use		X	X				X			X			X	X
Mineral Oil (Subset of Heavy Oil That is Highly Refined) Insulating Oil		X											X	X
Waste Oil Engine Lubricating Oil Hydraulic Fluid Industrial Process Oils Metalworking Oils and Lubricants Refrigeration/Compressor Oil Transmission/Differential Oil	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Preferred Practical Quantitation Limit (mg/kg)	5	25	0.005 for each isomer	0.001	0.001	0.001	0.5 for each naphthalene	0.005 for each VOC	0.02	0.05 for each cPAH	0.1	0.1, 0.5, 0.1, 5 respectively	0.04	Chemical Specific

Note:

[1] Other fuel additives and blending compounds consist of Tertiary-butyl alcohol (TBA), tertiary-amyl methyl ether (TAME), ethyl tertieary-butyl ether (ETBE), methanol and ethanol.

[2] Only lead is required by Ecology MTCA rule, however the disposal facility will likely require RCRA Metals (arsenic, barium, cadmium, chromium, lead, mercury, silver and selenium) and follow-up TCLP if the total concentration is 20 times the WAC 173-303-100 Dangerous Waste Regulation Maximum Concentration of Contaminants for the Toxicity Characteristic.

VOCs = Volatile Organic Compounds
BTEX = Benzene, Toulene, Ethylbenzene, Xylenes
MTBE = Methyl tert-butyl ether
EDB = 1,2-Dibromoethane
EDC = 1,2-dichloroethane
HVOCs = Halogenated Volatile Organic Compounds
PAHs = Polycyclic Aromatic Hydrocarbons
cPAHs = carcinogenic Polycyclic Aromatic Hydrocarbons
PCBS = Polychlorinated Bienphyls

MTCA = Model Toxics Control Act
TCLP = Toxicity Characteristic Leaching Procedure
RCRA = Resource Conservation and Recovery Act
EPA = Environmental Protection Agency

TABLE 5. GUIDELINES FOR ANALYTICAL METHODS AND MAXIMUM ALLOWABLE LEVELS

Apr 22 2004 8:58AM HP LASERJET 3200 p.2

GUIDELINES FOR ANALYTICAL METHODS AND MAXIMUM ALLOWABLE LEVELS

PARAMETER	WASTE CODE	MAX. ALLOWABLE LEVELS		ANALYTICAL METHODS**
		TCLP (mg/L)	TOTAL* (mg/kg)	
TCLP METALS				
Arsenic	D004	<5.0	100	SW-846-1311/SW-846-6010
Barium	D005	<100.00	2000	SW-846-1311/SW-846-6010
Cadmium	D006	<1.0	20	SW-846-1311/SW-846-6010
Chromium	D007	<5.0	100	SW-846-1311/SW-846-6010
Lead	D008	<5.0	100	SW-846-1311/SW-846-6010
Mercury	D009	<0.2	4	SW-846-1311/SW-846-7470
Selenium	D010	<1.0	20	SW-846-1311/SW-846-7740
Silver	D011	<5.0	100	SW-846-1311/SW-846-6010
TCLP VOLATILES				
Benzene	D018	<0.5	10	SW-846-1311/SW-846-8260
Carbon Tetrachloride	D019	<0.5	10	SW-846-1311/SW-846-8260
Chlorobenzene	D021	<100.0	2000	SW-846-1311/SW-846-8260
Chloroform	D022	<6.0	120	SW-846-1311/SW-846-8260
1,2-Dichloroethane	D028	<0.5	10	SW-846-1311/SW-846-8260
1,1-Dichloroethylene	D029	<0.7	14	SW-846-1311/SW-846-8260
Methyl Ethyl Ketone	D035	<200.0	4000	SW-846-1311/SW-846-8260
Tetrachloroethylene	D039	<0.7	14	SW-846-1311/SW-846-8260
Trichloroethylene	D040	<0.5	10	SW-846-1311/SW-846-8260
Vinyl Chloride	D043	<0.2	4	SW-846-1311/SW-846-8260
TCLP SEMI-VOLATILES (Base Neutrals)				
1,4 Dichlorobenzene	D027	<7.5	150	SW-846-1311/SW-846-8270
Hexachlorobenzene	D032	<0.13	2.6	SW-846-1311/SW-846-8270
Hexachlorobutadiene	D033	<0.5	10	SW-846-1311/SW-846-8270
Hexachloroethane	D034	<3.0	60	SW-846-1311/SW-846-8270
Nitrobenzene	D036	<2.0	40	SW-846-1311/SW-846-8270
Pyridine	D038	<5.0	100	SW-846-1311/SW-846-8270
2,4-Dinitrotoluene	D030	<0.13	2.6	SW-846-1311/SW-846-8270
TCLP SEMI-VOLATILES (Acid Compounds)				
o-Cresol	D023	<200.0	4000	SW-846-1311/SW-846-8270
m-Cresol	D024	<200.0	4000	SW-846-1311/SW-846-8270
p-Cresol	D025	<200.0	4000	SW-846-1311/SW-846-8270
Cresol, Total	D026	<200.0	4000	SW-846-1311/SW-846-8270
Pentachlorophenol	D037	<100.0	2000	SW-846-1311/SW-846-8270
2,4,5-Trichlorophenol	D041	<400.0	8000	SW-846-1311/SW-846-8270
2,4,6-Trichlorophenol	D042	<2.0	40	SW-846-1311/SW-846-8270
TCLP HERBICIDES				
2,4-D	D016	<10.0	200	SW-846-1311/SW-846-8080
2,4,5-TP (Silvex)	D017	<1.0	20	SW-846-1311/SW-846-8080
TCLP PESTICIDES				
Chlorodane	D020	<0.03	0.6	SW-846-1311/SW-846-8080
Endrin	D012	<0.02	0.4	SW-846-1311/SW-846-8080
Heptachlor	D031	<0.008	0.16	SW-846-1311/SW-846-8080
Lindane	D013	<0.4	8	SW-846-1311/SW-846-8080
Methyoxychlor	D014	<10.0	200	SW-846-1311/SW-846-8080
Toxaphene	D015	<0.5	10	SW-846-1311/SW-846/8080
GENERAL				
pH	D002	2.0 < x <12.5		SW-846-9045
Ignitability (Liquids Only)	D001	>140°F (60°C)		SW-846-C7
Free Liquids		NO FREE LIQUIDS		SW-846-9095
PCB's		<50 mg/kg or ppm		SW-846-8080
TPH		Varies by landfill		SW-846-8015, EPA 418.1 API-(GC/FID), ASTM-D3987-85/SW-846-

* If the TOTAL results are greater than 20 times the TCLP levels, than TCLP must be performed.
** These analytical methods are only suggested methods, other methods may be utilized.

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Provided by Allied Waste

QUALITY CONTROL AND QUALITY ASSURANCE SAMPLE STORAGE

Data Quality Objectives

The quality assurance objective for technical data is to collect environmental monitoring data of known, acceptable and documentable quality. The QA objectives established for the project are:

- Implement the procedures outlined herein for field sampling, sample custody, equipment operation and calibration, laboratory analysis, and data reporting that will facilitate consistency and thoroughness of data generated.
- Achieve the acceptable level of confidence and quality required so that data generated are scientifically valid and of known and documented quality. This will be performed by establishing criteria for precision, accuracy, representativeness, completeness and comparability, and by testing data against these criteria.

The sampling design, field procedures, laboratory procedures, and quality control (QC) procedures are set up to provide high-quality data. Specific data quality factors that may affect data usability include quantitative factors (detection limits, precision, and accuracy) and qualitative factors (comparability). The measurement quality objectives (MQO) associated with the data quality factors are discussed below.

Detection Limits

Analytical methods have quantitative limitations at a given statistical level of confidence that are often expressed as the method detection limit (MDL). Although results reported near the MDL provide insight to site conditions, quality assurance dictates that analytical methods achieve a consistently reliable level of detection known as the practical quantitation limit (PQL), which is typically demonstrated with the lowest point of a linear calibration. The contract laboratory will provide numerical results for all analytes and report them as detected above the PQL or undetected at the PQL.

The PQL for the target analytes are presented in Table 4 for soil. These reporting limits were obtained from Ecology's Guidance for Remediation of Petroleum Contaminated Sites (Publication No. 10-09-057). The PQLs in Table 4 that are considered target reporting limits (TRLs) because several factors may influence final reporting limits. First, moisture and other physical conditions of soil affect detection limits. Second, analytical procedures may require sample dilutions or other practices to accurately quantify a particular analyte at concentrations above the range of the instrument. The effect is that other analytes could be reported as undetected but at a value higher than a specified TRL. Data users must be aware that high non-detect values, although correctly reported, can bias statistical summaries and careful interpretation is required to correctly characterize site conditions.

Precision

Precision is the measure of mutual agreement among replicate or duplicate measurements of an analyte from the same sample and applies to field duplicate or split samples, replicate analyses, and duplicate spiked environmental samples (matrix spike duplicates). The closer the measured values are to each other, the more precise the measurement process. Precision error may affect data usefulness. Good precision is indicative of relative consistency and comparability between

different samples. Precision will be expressed as the relative percent difference (RPD) for spike sample comparisons of various matrices and field duplicate comparisons.

This value is calculated by:

$$RPD\ (\%) = \frac{|D_1 - D_2|}{(D_1 + D_2)/2}\ X\ 100,$$

Where:

D_1 = Concentration of analyte in sample.

D_2 = Concentration of analyte in duplicate sample.

The calculation applies to split samples, replicate analyses, duplicate spiked environmental samples (matrix spike duplicates) and laboratory control duplicates. The RPD will be calculated for samples and compared to the applicable criteria. Precision can also be expressed as the percent difference (%D) between replicate analyses. Persons performing the evaluation must review the pertinent document (USEPA, 2004) that addresses criteria exceedances and courses of action. Project RPD goals for all analyses are 35 percent for water samples and 50 percent for soil samples, unless the primary and duplicate sample results are less than five times the MRL, in which case RPD goals will not apply for data quality assessment purposes.

Accuracy

Accuracy is a measure of bias in the analytic process. The closer the measurement value is to the true value, the greater the accuracy. This measure is defined as the difference between the reported values versus the actual value and is often measured with the addition of a known compound to a sample. The amount of known compound reported in the sample, or percent recovery, assists in determining the performance of the analytical system in correctly quantifying the compounds of interest. Since most environmental data collected represent one point spatially and temporally rather than an average of values, accuracy plays a greater role than precision in assessing the results. In general, if the percent recovery is low, non-detect results may indicate that compounds of interest are not present when in fact these compounds are present. Detected compounds may be biased low or reported at a value less than actual environmental conditions. The reverse is true when recoveries are high. Non-detect values are considered accurate while detected results may be higher than the true value.

For most accuracy will be expressed as the percent recovery of a known surrogate spike, matrix spike, or laboratory control sample (blank spike), concentration:

$$Recovery\ (\%) = \frac{Spiked\ Result - Unspiked\ Result}{Known\ Spike\ Concentration}\ X\ 100$$

Persons performing the evaluation must review the pertinent document (USEPA, 2004) that addresses criteria exceedances and courses of action.

Comparability

Comparability expresses the confidence with which one set of data can be compared to another. Although numeric goals do not exist for comparability, a statement on comparability will be prepared to determine overall usefulness of data sets, following the determination of both precision and accuracy.

Holding Times

Holding times are defined as the time between sample collection and extraction, sample collection and analysis, or sample extraction and analysis. Some analytical methods specify a holding time for analysis only. For many methods, holding times may be extended by sample preservation techniques in the field. If a sample exceeds a holding time, then the results may be biased low. Holding times are presented in Table 4.

Sample Handling and Custody

Sample Storage

Individual samples should be placed in a cooler with "blue ice" or double-bagged "wet ice" immediately after they are collected. The objective of the cold storage should be to attain a sample temperature of 4 degrees Celsius. Holding times should be observed during sample storage.

Sample Shipment

The samples should be transported and delivered to the analytical laboratory in coolers. Field personnel should transport and hand-deliver samples to the laboratory or to a laboratory courier for analysis.

Chain-Of-Custody Records

Field personnel are responsible for the security of samples from the time the samples are collected until the samples have been received by the laboratory or courier. A COC form should be completed at the end of the field day for samples being shipped to the laboratory. Information to be included on the COC form includes:

- Project name and number.
- Sample identification numbers.
- Date and time of sampling.
- Sample matrix and number of containers from each sampling point, including preservatives used.
- Analyses to be performed or samples to be archived.
- Names of sampling personnel and transfer of custody acknowledgment spaces.

Field personnel shall retain carbon copies and place the original and remaining copies in a plastic bag, placed within the cooler or taped to the inside lid of the cooler before sealing the container for transport. This record should accompany the samples during transit by the field team member or courier to the laboratory.

Laboratory Custody Procedures

The laboratory should follow their standard operating procedures (SOPs) to document sample handling from time of receipt (sample log-in) to reporting. Documentation should include at a minimum, the analysts name or initial, and the time and date of analysis.

Field Documentation

Field documentation provides important information about potential problems or special circumstances surrounding sample collection. Field personnel should maintain daily field logs while on site. Entries in the field logs and associated sample documentation forms should be made in waterproof ink on Rite-in-the-Rain paper, or waterproof ink on standard paper. Corrections should consist of line-out deletions that are initialed and dated. Individual logs should become part of the project files.

At a minimum, the following information should be recorded during the collection of each sample:

1. Sample location and description
2. Sampler's name(s)
3. Date and time of sample collection
4. Type of sample
5. Type of sampling equipment used
6. Field instrument readings as appropriate
7. Field observations and details that are pertinent to the integrity/condition of the samples (e.g., weather conditions, performance of the sampling equipment, sample depth control, etc.)
8. Sample preservation

In addition to the sampling information, the following specific information also should be recorded in the field log for each day of sampling:

9. Names of team members
10. Time of Property arrival/departure
11. Other personnel present at the Property as appropriate
12. Summary of pertinent meetings or discussions with regulatory agency
13. Deviations from sampling plans, site safety plans and QAPP procedures
14. Changes in personnel and responsibilities with reasons for the changes
15. Levels of safety protection
16. Calibration readings for any equipment used and equipment model and serial number

Photographs

All photographs taken of field activities will be documented with the following information noted in the field notebook:

- Date, time and location of photograph taken;
- Description of photograph taken;
- Reasons photograph was taken;
- Sequential number of the photograph and the film roll number (if film is used); and
- Viewing direction.

Digital photographs will be reviewed in the field using the camera view screen to assess photographic quality and the need to retake the photograph.

SAMPLING EQUIPMENT DECONTAMINATION

Reusable sampling equipment (stainless steel bowls, etc.) that comes in contact with soil should be decontaminated before each use. Decontamination procedures for this equipment should consist of the following: 1) wash with non-phosphate detergent solution (Alconox and distilled water), 2) rinse with distilled water, and 3) second distilled water rinse. Field personnel should limit cross-contamination by changing gloves between sampling events or more frequently as needed. Wash water used to decontaminate the sampling equipment is expected to be de minimis and shall be disposed of onto the soil/water that is being characterized for disposal.

SPECIAL TRAINING AND CERTIFICATION

All personnel conducting sampling activities must have successfully completed the required Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training program per 29 Code of Federal Regulations (CFR) 1910.120. Additionally, these individuals must have completed an annual eight-hour refresher training within the previous year.

Prior to starting field activities, all personnel working should be briefed on potential site hazards, health and safety procedures, and sampling procedures. After completion of this training, all personnel will be required to sign an acknowledgement form verifying that they have completed the task-specific training.

REFERENCES

U.S. Environmental Protection Agency (USEPA), "Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, OSWER 9240.1-45, EPA 540-R-04-004." October 2004.

Washington State Department of Ecology (Ecology), "Guidance for Remediation of Petroleum Contaminated Sites, Publication 10-09-057" dated September 2011.

Washington State Department of Ecology (Ecology), "Implementation Memorandum, #5, Collecting and Preparing Samples for VOC Analysis, Publication 04-09-087," dated June 2004.

APPENDIX A
MiniRae 2000 PID Manual

BOX 2

MiniRAE 2000

Portable VOC Monitor
PGM-7600

OPERATION AND MAINTENANCE MANUAL

(Document No.: 011-4001)
Revision D, June 2004

RAE SYSTEMS

ISO 9001 CERTIFIED

4.4 Calibrate and Select Gas

WARNINGS

The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service for the first time.

For maximum safety, the accuracy of the MiniRAE 2000 should be checked by exposing it to known concentration calibration gas before each day's use.

In the first menu of the programming mode, the user can perform functions such as calibration of the MiniRAE 2000 Monitor, select default cal memories, and modify cal memories.

Calibrate/Select Gas Sub-Menu

Fresh Air Cal?

Span Cal?

Select Cal Memory?

Change Span Value?

Modify Cal Memory?

Change Correction Factor?

Calibrating the MiniRAE 2000 monitor is a two-point process using "fresh air " and the standard reference gas (also known as span gas). First a "Fresh air" calibration, which contains no detectable VOC (0.0 ppm), is used to set the zero point for the sensor. Then a standard reference gas that contains a known concentration of a given gas is used to set the second point of reference.

Note: The span value must be set prior to calibrating for fresh air or span.

The user can store calibrations for up to 8 different measurement gases. The default gas selections are as follows:

Cal Memory #0.....Isobutylene

Cal Memory #1.....Hexane

Cal Memory #2.....Xylene

Cal Memory #3.....Benzene

Cal Memory #4.....Styrene

Cal Memory #5.....Toluene

Cal Memory #6.....Vinyl Chloride

Cal Memory #7.....Custom?

Memory #0 functions differently than the other 7 memories. For Memory #0, isobutylene is always the calibration gas. When the gas is changed in Memory #0 to one of 100 other preprogrammed chemicals or to a user-defined custom gas, a correction factor is applied to all the readings. During calibration, the unit requests isobutylene gas and displays the isobutylene concentration immediately following calibration, but when the unit is returned to the normal reading mode, it displays the selected gas and applies the correction factor.

The other 7 cal memories require the same calibration gas as the measurement gas. These memories may also be modified to a preprogrammed chemical or to a user-defined custom gas. In the gas library, only the gases that can be detected by the installed UV lamp will actually be displayed. Note that although the correction factor for the new gas will be displayed and can be modified, this factor is not applied when Memories #1-7 are used. Therefore the factor will not affect the readings in these memories.

Once each of the memories has been calibrated, the user can switch between the calibrated gases by changing the cal memory without the need to recalibrate. Or the user can switch the measurement gas in Memory #0 and the appropriate correction factor will automatically be applied without the need to recalibrate. If the gas is changed in Memories #1-7, it is necessary to recalibrate.

To change a default gas from the list above to a library or custom gas, first go to Select Cal Memory (Section 4.4.3) and then proceed to Modify Cal Memory (Section 4.4.5) to enter the desired gas. If the desired compound does not appear in the preprogrammed library, the user can use the Custom_VOC entry in the library, or the name and correction factor of any of the existing compounds can be changed as described in Section 4.4.5. A list of some 300 correction factors is given in Technical Note 106, available at the website www.raesystems.com.

4.4.1 Fresh Air Calibration

This procedure determines the zero point of the sensor calibration curve. To perform a fresh air calibration, use the calibration adapter to connect the MiniRAE 2000 to a "fresh" air source such as from a cylinder or Tedlar bag (option accessory). The "fresh" air is clean dry air without any organic impurities. If such an air cylinder is not available, any clean ambient air without detectable contaminant or a charcoal filter can be used.

1. The first sub-menu shows: "Fresh air Cal?"
2. Make sure that the MiniRAE 2000 is connected to one of the "fresh" air sources described above.
3. Press the **[Y/+]** key, the display shows "zero in progress" followed by "wait.." and a countdown timer.

After about 15 seconds pause, the display will show the message "update data…zeroed… reading = X.X ppm…" Press any key or wait about 20 seconds, the monitor will return back to "Fresh air Calibration?" submenu.

4.4.2 Span Calibration

This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar Bag, or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the MiniRAE 2000 Monitor, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

Before executing a span calibration, make sure the span value has been set correctly (see next sub-menu).

1. Make sure the monitor is connected to one of the span gas sources described above.
2. Press the **[Y/+]** key at the "Span Cal?" to start the calibration. The display shows the gas name and the span value of the corresponding gas.
3. The display shows "Apply gas now!" Turn on the valve of the span gas supply.

4. Display shows "wait.... 30" with a count down timer showing the number of remaining seconds while the monitor performs the calibration.
5. To abort the calibration, press any key during the count down. The display shows "Aborted!" and return to "Span Cal?" sub-menu.
6. When the count down timer reaches 0, the display shows the calibrated value.

   Note: The reading should be very close to the span gas value.
7. During calibration, the monitor waits for an increased signal before starting the countdown timer. If a minimal response is not obtained after 35 seconds, the monitor displays "No Gas!" Check the span gas valve is on and for lamp or sensor failure before trying again.
8. The calibration can be started manually by pressing any key while the "Apply gas now!" is displayed.
9. After a span calibration is completed, the display will show the message "Update Data Span Cal Done! Turn Off Gas."
10. Turn off the flow of gas. Disconnect the calibration adapter or Tedlar bag from the MiniRAE 2000 Monitor.
11. Press any key and it returns back to "Span Gas Cal?"

4.4.3 Select Cal Memory

This function allows the user to select one of eight different memories for gas calibration and measurement. For Memories #1-7, the calibration and measurement gas is the same and no correction factor is applied. For Memory #0, the calibration gas is always isobutylene and the measurement gas may be different, in which case the correction factor for that gas is automatically applied. The default gas selections are listed in Section 4.4

1. "Select Cal Memory?" is the third sub-menu item in the Calibration sub-menu. Pressing the **[Y/+]** key, the display will show "Gas =" gas name followed by "Mem # x?"
2. Press **[N/-]** to scroll through all the memory numbers and the gas selections respectively. Press **[Y/+]** to accept the displayed Cal Memory number.
3. After the **[Y/+]** key is pressed, the display shows "Save?" Press **[Y/+]** key to save and proceed. Press **[N/-]** to discard the entry and advance to the next sub-menu.
4. If the gas in a newly selected Cal Memory number is not calibrated, the display shows "CF= x.xx". A correction factor with the value "x.xx" will be applied.
5. If the gas of a newly selected cal memory number has been calibrated previously, the display shows "Last calibrated xx/xx/xx".

1. GENERAL INFORMATION

MiniRAE 2000 Portable VOC Monitor (Model PGM 7600) is a compact monitor designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It monitors Volatile Organic Compounds (VOC) using a Photo-Ionization Detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas discharge lamp. Features are:

- **Lightweight and Compact**
  -Compact, light weight (19 oz.) and rugged design
  -Built-in sample draw pump

- **Dependable and Accurate**
  - Up to 10 hours of continuous monitoring with rechargeable battery pack
  - Designed to continuously monitor VOC vapor at ppm levels

- **User Friendly**
  -Preset alarm thresholds for STEL, TWA, low and high level peak values. Audio buzzer and flashing LED display are activated when the limits are exceeded.

- **Datalogging Capabilities**
  -15,000 point datalogging storage capacity for data download to PC

MiniRAE 2000 consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged ABS + PC case with a backlit 1 line by 8 character dot matrix LCD and 3 keys to provide easy user interface.

1.1 General Specifications

Table 1.1

Portable VOC Monitor Specification	
Size:	8.2"L x 3.0"W x 2.0"H
Weight:	19.5 oz with battery pack
Detector:	Photo-ionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 4.8V /1250 mAH Rechargeable Nickel Metal Hydride battery pack (snap in, field replaceable)
Battery Charging:	10 hours charge through built-in charger
Operating Hours:	Up to10 hours continuous operation
Display:	1 line by 8 characters 5x7 dot matrix LCD (0.4" character height) with LED back light automatically in dim light
Range, Resolution & Response time (t_{90}):	
Isobutylene (calibration gas)	
	0-99 ppm 0.1 ppm 2 sec
	100-1,999 ppm 1.0 ppm 2 sec
	2000-10,000 ppm 1.0 ppm 2 sec
Measurement Accuracy (Isobutylene):	
	0 – 2000 ppm: ± 2 ppm or 10% of reading.
	> 2000 ppm: ± 20% of reading
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Built-in 102 VOC gases
Calibration:	Two-point field calibration of zero and standard reference gas
Calibration Memory:	
	Store up to 8 separate calibration, alarm limits and span value
Inlet Probe:	Flexible 5" tubing
Keypad:	1 operation key and 2 programming keys

Direct Readout:	Instantaneous, average, STEL and peak value, battery voltage and elapsed time
Intrinsic Safety:	UL & cUL Class 1, Division I, Group A,B,C,D, Temperature Code T3C (US & Canada); CE 0575 Ex II 1G DEMKO 02 ATEX 0204759 Eex ia IIC T4 (Europe)
EM Interference:	No effect when exposed to 0.43 W/cm^2 RF interference (5 watt transmitter at 12 inches)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Survey or Hygiene mode
Alarm:	90 dB buzzer and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure.
External Alarm:	Optional plug-in pen-size vibration alarm or remote alarm
Alarm Mode:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on data logged information
Datalogging:	15,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC through RS-232 port
Sampling Pump:	Internally integrated. Flow rate: 450-550 cc/min.
Temperature:	0° to 45°C (32° to 113°F)
Humidity:	0 % to 95 % relative humidity (non-condensing)
Housing:	ABS + PC, conductive coating, splash and dust proof, will withstand 1 meter drop test with rubber boot
Attachment:	Wrist strap, rubber boot and belt clip

APPENDIX B
Ecology Guidance Regarding Reuse of Petroleum-Impacted Soil

Obtained from Washington State Department of Ecology's Guidance for Remediation of Petroleum Contaminated Sites, Publication No. 10-09-057, dated September 2011

12.0 REUSE OF PETROLEUM-CONTAMINATED SOILS

Ecology recognizes that cleanup of petroleum-contaminated sites is expensive. Landfilling of contaminated soils and the associated transportation costs greatly increases cleanup costs and contribute to greenhouse gas production. Heavily contaminated soils, of course, must be properly treated or disposed of to ensure that human health and the environment remain protected. However, for moderately or lightly contaminated soils, or soils with most of the contamination removed by treatment, a number of alternatives exist.

Under Washington State's Solid Waste and Hazardous Waste laws, one of the highest priorities for managing waste is to recycle or reuse waste materials. MTCA also states that remedial actions should provide for permanent solutions to the maximum extent practical. Consistent with these statutory priorities, Ecology offers the guidelines for best management practices in this section to facilitate the productive reuse of petroleum-contaminated soils generated by petroleum contaminated site cleanups. Soils managed consistent with these guidelines will most likely be protective of human health and the environment based on Ecology's past experience. Soils with contaminants other than petroleum-related are not addressed by these guidelines and these guidelines should not be used for these soils.

Petroleum contaminated soils are considered solid waste and, as such, are regulated by local health departments/districts. Some local health departments/districts may require a permit for reuse of these soils or have more restrictive reuse regulations. Use of these soils in public rights of way or easements is typically controlled by the local public works department. Use of these soils may also be subject to local land use laws and shoreline regulations. These agencies should be consulted before reusing the soil in accordance with these guidelines.

Petroleum contaminated soils generated by the cleanup of regulated UST facilities are exempt from most of the dangerous waste management requirements under WAC 173-303-071(3)(t). But other types of petroleum contaminated soil are not exempt. While the values in this table are generally well below concentrations that are likely to trigger regulation of the soil as a hazardous waste, if the soil was classified as a hazardous waste prior to treatment, or contains a listed waste, it may still be a regulated hazardous waste even with low contaminant levels. If this is a potential concern at a site, the soil will likely need to be managed as hazardous waste. Consult with Ecology's Hazardous Waste & Toxics Reduction Program in these cases. For more information see: http://www.ecy.wa.gov/programs/hwtr/index.html.

The general guidance in this section should not be construed as an endorsement of the reuse of any particular soils or a guarantee that any particular soils can be safely reused. All reuse decisions need to be made in the context of the individual site in compliance with all applicable laws. This section is not in any way intended to substitute for best professional judgment or override state or local regulatory requirements. Furthermore, reuse of petroleum-contaminated soils consistent with this section does not relieve any party of any resulting liability, including but not limited to MTCA liability, common law liability for nuisance conditions or a reduction in property value caused by aesthetic issues like odors, should a subsequent problem arise.

Persons may propose another site-specific basis for the reuse of petroleum-contaminated soil. This will require detailed site-specific characterization of the soil composition and variability (including testing for equivalent carbon fractions) and bioassays. A risk assessment evaluating all potential exposure pathways would also need to be conducted. This information will need to be submitted to Ecology's Waste to Resources Program and the local Health Department/District.

12.1 Factors Considered in the Development of Soil Re-use Categories

Table 12.1 provides recommended categories for reuse of petroleum contaminated soils. These values are based on evaluation of multiple potential exposure pathways and other considerations. Several values in Table 12.1 are more stringent than the Method A MTCA soil cleanup levels. There are several reasons for this:

- The solid waste handling standards, Chapter 173-350 WAC, apply to soils containing "harmful substances" removed during a cleanup. As noted below, petroleum-contaminated soils can cause harm in ways not considered under the MTCA Method A cleanup levels.
- For a variety of reasons, the Method A table values do not consider all potential exposure pathways and assume exposure conditions that may not be protective at all sites. For example, under Method A the soil is assumed to not impact surface water and terrestrial ecological risk is addressed separately. Under MTCA, Ecology has the authority to require more stringent cleanup levels than the Method A values on a site-specific basis. It is not practical to apply that level of site-specific judgment to reuse.
- Cleanup sites are typically cleaned to concentrations below the Method A cleanup levels to ensure the cleanup levels are met. However, the reuse categories set maximum not to exceed concentrations. Thus, for a given concentration, a soil reused under these guidelines is likely to have a higher TPH concentration than soil remaining after cleanup.
- At cleanup sites, it is possible to find out if the site was once contaminated through a site assessment or review of historical uses and cleanup records. However, because soil meeting these reuse categories can be reused on uncontaminated properties, property owners and workers will most likely not have similar information available and thus are unlikely to take any precautions regarding exposure.
- There is no state-wide permitting process controlling where soils meeting the reuse categories are used or requiring institutional controls to limit exposures.
- More data is available now than was available when the Method A soil cleanup levels were developed. This data indicates there is considerable product variability and this variability has been taken into account in developing these reuse categories.
- PCB-contaminated soils are not recommended for any reuse because of the persistence, toxicity and bioaccumulation potential of these compounds. This is consistent with Ecology's approach to regulation of these chemical mixtures under other authorities.

12.2 How to Determine Compliance with Soil Re-use Categories

Soils proposed for reuse should be tested for the parameters specified in Table 12.1, consistent with Table 7.2 for the product being cleaned up. The frequency of testing should be consistent with Table 6.9 for stockpiled soil, with the volume consisting of the amount of soil planned for reuse in any given reuse project, or a suitable alternative sampling plan submitted to the local regulatory agency for approval. To conform with these reuse categories, no sample should exceed the recommended values. If one or more samples exceed the recommended values, Ecology recommends that portion of the soil represented by that test result be separated from the other soil and appropriately disposed of. Soil samples bracketing the area should be taken to confirm whether the remainder of the soil qualifies for the selected category.

12.3 Soil Reuse Categories

Table 12.1 identifies four categories for re-use of petroleum contaminated soil. Table 12.2 describes uses and limitations for the four categories of soil. The footnotes to Table 12.1 are considered part of this Table and must be considered when reusing soils as specified in these tables.

While it is expected most petroleum contaminated soils will have been subjected to treatment prior to reuse, this is not a prerequisite for use of these guidelines. It may be possible, for example, through careful field screening using the methods described in Section 5 and segregation during excavation, to separate soils on the outer fringe of contamination or above the release that are only slighted contaminated. These soils may meet a particular soil reuse category without treatment.

Table 12.1 Guidelines for Reuse of Petroleum-Contaminated Soil					
Parameter	**Analytical Method**	**Soil Category (8)(9)(10)**			
		1 No detectable Petroleum Components (mg/kg)	**2 Commercial Fill Above Water Table (mg/kg)**	**3 Paving Base Material & Road Construction (mg/kg)**	**4 Landfill Daily Cover or Asphalt Manufacturing (mg/kg)**
Total Petroleum Hydrocarbons (1)(2) See Table 7.1 for petroleum products that fall within these categories.					
Gasoline Range Organics	NWTPH-Gx	<5	5 - 30	>30 - 100	>100
Diesel Range Organics	NWTPH-Dx	<25	25 - 200	>200 - 500	>500
Heavy Fuels and Oils*	NWTPH-Dx	<100	100 - 200	>200 – 500	>500
Mineral Oil	NWTPH-Dx	<100	100 - 200	>200 – 500	>500
Volatile Petroleum Components					
Benzene	SW8260B	<0.005	0.005 - 0.03	0.03 or less	See Table 12.2
Ethyl benzene	SW8260B	<0.005	0.005 - 6	6 or less	>6
Toluene	SW8260B	<0.005	0.005 - 7	7 or less	>7
Xylenes (3)	SW8260B	<0.015	0.015 - 9	9 or less	>9
Fuel Additives & Blending Components					
(MTBE) Methyl Tert-Butyl Ether	SW8260B	<0.005	0.005 - 0.1	0.1 or less	>0.1
Lead	SW6010A	<17	17 - 50	>50 - 220	See Table 12.2
Other Petroleum Components					
Polychlorinated (4) Biphenyls (PCBs)	SW8082	<0.04	<0.04	<0.04	See Table 12.2
Naphthalenes (5)	SW8260B	<0.05	0.05 - 5	5 or less	>5
cPAHs (6)	SW8270C	<0.05	0.05 - 0.1	>0.1 - 2	>2
Other Petroleum Characteristics (Applies to soils contaminated with any petroleum product.)					
Odors	Smell	No detectable odor			
Staining	Visual	No unusual color or staining			
Sheen Test	See Footnote # 7	No visible sheen			

IMPORTANT: See Table 12.2 and the footnotes to this Table on the following pages!
Test soil for the parameters specified in Table 7.2.
****Does NOT include waste oil contaminated soils, which should be disposed of in a landfill.***
"<" means less than; ">" means greater than

Table 12.2 Description and Recommended Best Management Practices for Soil Categories in Table 12.1 (continues on next page)		
Category	**Acceptable Uses**	**Limitations**
Category 1 Soils: Soils with no detectable/ quantifiable levels of petroleum hydrocarbons or constituents using the analytical methods listed in Table 7.3 and are not suspected of being contaminated with any other hazardous substances.	• Can be used anywhere the use is allowed under other regulations. • Any use allowed for Category 2, 3 & 4 soils.	• These soils may have a slight petroleum odor, depending on the sensitivity of individuals, and this should be considered when reusing these soils.
Category 2 Soils: Soils with residual levels of petroleum hydrocarbons that could have adverse impacts on the environment in some circumstances.	• Any use allowed for Category 3 & 4 soils. • Backfill at cleanup sites above the water table. • Fill in commercial or industrial areas above the water table. • Road and bridge embankment construction in areas above the water table.	• Should be placed above the highest anticipated high water table. If seasonal groundwater elevation information is not available, place at least 10 feet above the current water table. • Should not be placed within 100 feet of any private drinking water well or within the 10 year wellhead protection area of a public water supply well. • Should not be placed in or directly adjacent to wetlands or surface water where contact with water is possible. • Should not be placed under a surface water infiltration facility or septic drain field. • Any other limitations in state or local regulations.
Category 3 Soils: Soils with moderate levels of residual petroleum contamination that could have adverse impacts on the environment unless re-used in carefully controlled situations.	• Any use allowed for Category 4 soils. • Use as pavement base material under public and private paved streets and roads. • Use as pavement base material under commercial and industrial parking lots.	• Should be placed above the highest anticipated high water table. If seasonal ground water elevation information is not available, place at least 10 feet above the water table. • Should be a maximum of 2 feet thick to minimize potential for leaching or vapor impacts. • Should not be placed within 100 feet of any private drinking water well or within the 10 year wellhead protection area of a public water supply well. • Should not be placed in or directly adjacent to wetlands or surface water. • Should not be placed under a surface water infiltration facility or septic drain field. • When exposed, runoff from area in use should be contained or treated to prevent entrance to storm drains, surface water or wetlands. • Any other limitations in state or local regulations.

Table 12.2 Description and Recommended Best Management Practices for Soil Categories in Table 12.1 (continued)		
Category	**Acceptable Uses**	**Limitations**
<u>Category 4 Soils:</u> Soils with high levels of petroleum contamination that should not be re-used except in very limited circumstances.	• Use in the manufacture of asphalt. • Use as daily cover in a lined municipal solid waste or limited purpose landfill provided this is allowed under the landfill operating permit.	**<u>Landfill Limitations:</u>** The soil should be tested for and pass the following tests: ➢ Free liquids test. Soils that contain free liquids cannot be landfilled without treatment. ➢ TCLP for lead and benzene. Unless exempt under WAC 173-303-071(3)(t), soils that fail a TCLP for lead or benzene must be disposed of as hazardous waste. ➢ Flammability test. Soils that fail this test must be disposed of as hazardous waste. ➢ Bioassay test under WAC 173-303-100(5). Soils that fail this test must be disposed of as hazardous waste. ➢ PCBs. Soils with a total PCB content of 2 ppm or more must be disposed of as hazardous waste. Soil used for daily cover should be stockpiled within the landfill lined fill area. Soil containing more than 10,000 mg/kg TPH should be buried immediately with other wastes or daily covered to limit potential worker exposure. Any additional limitations specified in the landfill permit or in other state or local regulations. **<u>Asphalt Manufacturing Limitations:</u>** Soil storage areas should be contained in a bermed area to minimize contact with surface water runoff from adjacent areas. Runoff from storage areas should be considered contaminated until tested to prove otherwise. Soil storage areas should also be lined and covered with a roof or secured tarp to minimize contact with precipitation and potential groundwater contamination. Leachate from storage areas should be considered contaminated until tested to prove otherwise. The soil should be tested for and pass the following tests: ➢ TCLP for lead and benzene. Unless exempt under WAC 173-303-071(3)(t), soils that fail a TCLP for lead or benzene must be disposed of as hazardous waste. ➢ Flammability test. Soils that fail this test must be disposed of as hazardous waste. ➢ Bioassay test under WAC 173-303-100(5). Soils that fail this test must be disposed of as hazardous waste. ➢ No detectable levels of PCBs in soil (<0.04 mg/kg). Precautions should be taken to minimize worker exposure to soil storage piles and any dust or vapors from these piles prior to feeding into the asphalt batch plant.
IMPORTANT: See the following page for additional information!		

Notes to Table 12.1:

Contaminated soils can be treated to achieve these concentrations but dilution with clean soil to achieve these concentrations is a violation of Washington State solid and hazardous waste laws.

(1) See Table 7.1 for a description of what products fall within these general categories. If the product released is unknown, use the limitations for gasoline range organics. If the soil is contaminated from releases from more than one product, use the limitations for both products. For example, if the release is a mixture of gasoline and diesel, the soil should be tested for components of both gas and diesel and the limitations for both fuels and their components used.

(2) The concentrations for diesel, heavy oil and mineral oil are not additive. Use the TPH product category most closely representing the TPH mixture and apply the limitations for that product to the mixture. ***The reuse of waste oil contaminated soil is not allowed due to the wide variety of contaminants likely to be present.***

(3) Value is total of m, o, & p xylenes.

(4) Value is the total of all PCBs. Only heavy oil and mineral oil contaminated soils need to be tested for PCBs. Soil contaminated with a spill from a regulated PCB containing device must be disposed of in a TSCA permitted landfill, regardless of the PCB concentration. Other PCB contaminated soils may be disposed of in a municipal solid waste landfill permitted to receive such materials, provided the concentration does not exceed 2 ppm PCBs (WAC 173-303-9904).

(5) Value is total of naphthalene, 1-methyl naphthalene and 2-methyl naphthalene. Only diesel and heavy oil contaminated soils need to be tested for naphthalenes.

(6) The value is the benzo(a)pyrene equivalent concentration of the following seven cPAHs, using the procedures in WAC 173-340-708(8). The seven cPAHs are as follows: benz(a)anthracene; benzo(b)fluoranthene; benzo(k)fluoranthene; benzo(a)pyrene; chrysene; dibenz(a,h)anthracene; and, indeno(1,2,3-cd)pyrene. Only diesel and heavy oil contaminated soils need to be tested for cPAHs. Soils contaminated with more than 1% polycyclic aromatic hydrocarbons, as that term is defined in WAC 173-303-040 (which is more expansive than the above list), must be disposed of as hazardous waste.

(7) No visible sheen observed on water when approximately one tablespoon of soil placed in approximately ½ liter of water held in a shallow pan (like a gold pan or similar container).

(8) A soil in a lower category can be used for uses specified in any higher category. This means that:

- A category 1 soil can be used for any use specified in categories 1, 2, 3 and 4.
- A category 2 soil can be used for any use specified in categories 2, 3 and 4.
- A categories 3 soil can be used for any use specified in categories 3 and 4.

(9) ***If an environmental site assessment or soil or groundwater analyses indicate contaminants other than common petroleum constituents and naturally occurring levels of metals are likely to be present in the soil of interest at the site (for example, solvents or pesticides), do not reuse the soil.*** The soil should instead be treated using appropriate technology to address all contaminants or landfilled at a solid waste or hazardous waste facility permitted to receive these materials.

(10) Soils in categories 2, 3 and 4 should be stockpiled consistent with the soil storage recommendations in Section 11.3 of this guidance.