GENERAL GUIDANCE FOR SELECTING PETROLEUM HYDROCARBON FIELD SCREENING METHODS
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PREFACE

This field screening guide is the product of a field screening methods evaluation initiated in the fall of 1997 and completed during the summer of 1999. The field screening methods evaluation was sponsored and managed by the Alaska Department of Environmental Conservation (ADEC). Funding to expand the scope and quality of the project was provided by the Alaska Science and Technology Foundation (ASTF). Partial funding was also provided by the Army Environmental Quality Research (EQT) Program 62720A/AF25, Project AF25-GR005 “Enhancing Low Cost Biotreatment in Cold Regions” for completion of a laboratory phase of the field screening methods evaluation and review of this guidance document. The evaluation was performed jointly by IT Corporation (formerly Fluor Daniel GTI) and the United States Army Cold Region Research and Engineering Laboratory (USACRREL). Participation and contribution by USACRREL, InControl Technologies, Inc. (specializing in environmental statistical analyses), Anchorage Soil Recycling (ASR), Analytica Alaska, and CT&E Laboratories were integral to the successful completion of the evaluation.

This document offers general guidance to responsible parties, project managers, and field technicians engaged in petroleum hydrocarbon assessment and remediation projects. The guidance is based upon data collected in a laboratory setting where variables affecting the performance of field screening technologies were controlled and monitored. Results from the laboratory phase of the evaluation were then used to design and perform a similar evaluation of field screening technologies under relatively uncontrolled conditions in the field. Lessons learned and general conclusions derived from the lab and field phases of the field screening methods evaluation are tabulated herein. This report is an informational presentation of field screening technologies and the selection and application of these technologies to meet site specific needs.

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ACRONYMS

ADEC	Alaska Department of Environmental Conservation
ASTF	Alaska Science and Technology Foundation
ASR	Alaska Soil Recycling
C-H	Carbon-Hydrogen
CT&E	Commercial Testing and Environmental
DQO	Data Quality Objective
ELISA	Enzyme-linked Immunosorbent Assay
EPA	Environmental Protection Agency
IRS	Infrared Spectrophotometry
O & G	Oil and Grease
TRPH	Total Recoverable Petroleum Hydrocarbons
USACRREL	United States Army Cold Regions Research and Engineering Laboratory
°C	Degrees Celsius

1.0 INTRODUCTION

Field screening soil or other materials containing petroleum hydrocarbons can be accomplished using multiple methods and techniques. These methods and techniques provide a variety of results. Appropriate application of field screening methods can provide valuable information to the environmental professional on a real-time, or near real-time basis. The information can be used to make important decisions in the field, when evaluated in conjunction with or confirmed by fixed laboratory analytical data.

Field screening results that correlate to data derived in the laboratory can be used to guide expensive assessment and remediation projects in the field, minimizing construction, sample preservation, sample shipment, and analytical expenses. In contrast, unreliable field screening methods and data impair assessment and remediation decisions. These poor decisions, particularly at remote locations, can result in excessive assessment and remediation costs and cause unnecessary delays. Therefor, the use of field screening technologies should be carefully planned. It is critical to understand the type and quality of data that will be generated before field screening methods are purchased and used in the field. Also, the interpretation of the data generated using field screening methods should be carefully evaluated before conclusions are drawn.

This field screening guidance document has been prepared to assist responsible parties and qualified environmental personnel in the selection and application of soil sample field screening methods. This guidance provides a description of the following:

- available field screening methods and test kit techniques,
- technologies employed for field screening,
- data quality objectives,
- method selection and performance criteria,
- usability of field screening results; and,
- general methods to improve the reliability of field screening data.

It is important to note that this project was initiated during fall 1997. Since the initiation of this project the commercial availability and technologies employed by the various screening methods has changed. Some techniques were added to the market, some manufactures modified their techniques, and some manufactures of field screening technologies eliminated their products from the market altogether. Additionally, it was not possible to evaluate all available technologies and techniques, nor was it possible to continually change the scope of the evaluation with each change in the market for field screening methods. Therefor, to maximize the benefit of using field screening technologies, the environmental professional should keep abreast of market changes and diligently inquire about the "latest and greatest" in field screening techniques when the need for such tools arise.

1.1 Background

The ADEC sponsored and funded this work to determine the reliability and usefulness of available methods to screen soil for petroleum hydrocarbons in the field. The study focused on screening for diesel and residual range organics since these petroleum mixtures offer unique challenges in the field due to the relative absence of volatile organic compounds in their chemical structures.

A two-phase approach was used during the field screening methods evaluation study. The first phase was conducted under controlled conditions in a laboratory. During this phase, several technologies were tested and the results were compared to data generated in a fixed laboratory. The second phase, or field phase, was performed using only those methods that provided statistically acceptable results during the laboratory phase. The field phase was conducted at a site that contained multiple soil stockpiles from various Alaska locations. The field screening data was compared to corresponding laboratory results and statistically evaluated using parametric procedures to determine the reliability of the test methods. Summarized results of the field screening methods evaluation have been incorporated into this general guidance document.

1.2 Objectives

This guidance document has been prepared to aid in the selection of field screening methods for use at petroleum hydrocarbon impacted sites undergoing assessment, underground and aboveground storage tank removal, and remediation of soil or other materials containing gasoline, diesel, and residual range petroleum hydrocarbons. This guidance provides assistance to the environmental professional selecting field screening methods to meet site specific conditions, as well as recommends general protocol to increase the usefulness of field screening results.

2.0 FIELD SCREENING METHODS

This section of the field screening guidance document summarizes the types of field screening methods that are readily available. It also describes general selection and performance criteria that should be considered before selecting any given field screening method.

Initially, field screening methods provided only qualitative or semi-quantitative results for use during drilling, trenching, tank removal, and soil excavation actions. The data generated provided a “yes/no” answer, and provided some relative indication of concentration. With technological innovations, field screening methods have been improved to provide semi-quantitative or quantitative results that may be comparable to analytical results generated by a fixed laboratory performing analysis using State of Alaska methods. This statement only holds true when factors affecting the field screening results are fully understood. Currently, field screening method results cannot be substituted for fixed laboratory analyses, but they can be used to quickly estimate petroleum hydrocarbon concentrations in the field and reduce the number of samples requiring testing in a fixed laboratory.

2.1 Summary of Methods

Several field screening methods are readily available to test soil samples in the field for the presence or quantity of petroleum hydrocarbons. The available methods employ numerous techniques that result in qualitative, semi-quantitative, and quantitative results. Field screening methods are improving as a result of technological innovations and the adoption of fixed laboratory technologies for field analyses. This guidance focuses on field screening methods that were available at the onset of the field screening methods evaluation and as of the date of this document.

For the purpose of this guidance, available field screening methods and techniques have been categorized as follows:

- Immunoassay
- Infrared Spectraphotometry
- Headspace Organic Vapor Monitoring
- Colorimetric Wet Chemistry
- Physical Screening Methods

Some of the commercially available field screening test kits use more than one technique for hydrocarbon quantification. As a result, some the field screening methods can be classified into more than one of the above categories. Techniques identified in each category above are described in detail in the following sections.

2.1.1 Immunoassay

Immunoassay field screening involves the detection and measurement of petroleum hydrocarbons using specific binding characteristics of antibodies and antigens. The antibodies form antibody/antigen compounds with molecules of specific organic compounds present in the petroleum hydrocarbon mixtures such as gasoline, diesel fuel, and motor oils. Most immunoassay test kits use an enzyme-linked immunosorbent assay (ELISA) process. In this process, the samples being tested are combined with a labeled enzyme that then competes for binding antibody sites. The process requires incubation prior to separation of bound and unbound antibodies. The bound antibodies are then quantified using secondary quantification processes.

The immunoassay methods generate quantitative and semi-quantitative results. Most of these methods have been designed to measure the presence and concentration of a variety of petroleum hydrocarbon mixtures. Concentration determinations are based upon a relative response to specific types of organic compounds or molecular structures present in all hydrocarbon mixtures. Therefore, it is possible to monitor for gasoline, diesel, and other hydrocarbon mixtures using immunoassay methods.

Immunoassay methods require methanol extraction of a known mass of soil containing petroleum hydrocarbons. The methanol extract is then introduced to the antibody/antigen reaction to focus the testing process on the appropriate target compounds. Once the antibody/antigen reaction has been terminated, colorimetric or turbidimetric processes are used to quantify the petroleum hydrocarbon mixture present in the soil.

2.1.2 Infrared Spectraphotometry

Infrared spectraphotometry (IRS) is typically used to measure the carbon-hydrogen bonds (C-H bonds) present in all petroleum hydrocarbon mixtures. IRS analytical methods were developed by the Environmental Protection Agency (EPA) in the 1980s to measure Oil and Grease (O&G – EPA method 413.2) and Total Recoverable Petroleum Hydrocarbons (TRPH - EPA method 418.1). These methods have been adapted for use as field screening methods.

The initial EPA methods used freon as an extraction solvent to recover petroleum hydrocarbons for analysis using IRS techniques. Due to environmental concerns associated with freon, the use of freon was discontinued, requiring modification of the EPA method. Other suitable solvents were identified. These solvents typically include hexane, carbon disulfide, tetrachloroethylene, and carbon tetrachloride. Carbon disulfide, tetrachloroethane, and carbon tetrachloride do not have C-H bonds. Therefor these three solvents are suitable for extraction and analysis using IRS techniques. Hexane is suitable for sample extraction but contains C-H bonds that must be removed prior to analysis. This method allows the quantification of various petroleum hydrocarbon mixtures.

Infrared spectraphotometric field screening techniques require the addition of silica gel to a known mass of petroleum hydrocarbon impacted soil prior to extraction using hexane or other suitable chlorinated solvents. The soil extract is then analyzed directly following calibration of the infrared spectraphotometer adjusted to the appropriate wavelength to measure the C-H bond emissions. The quantitative results are determined from the sample response relative to a set of calibration standards. The calibration standards are prepared using the extraction solvent and the appropriate petroleum hydrocarbon target analyte. The concentrations are determined based on project specific data quality objectives and require an understanding of basic chemistry for proper preparation.

2.1.3 Headspace Organic Vapor Monitoring

Headspace organic vapor monitoring involves the measurement of petroleum vapors emitted from soil samples in a sealed container. The headspace of the container is typically warmed and then is tested for organic compound vapors using ionization or colorimetric air monitoring techniques. The results generated by this method are qualitative to semi-quantitative and are limited primarily to volatile and semi-volatile organic compounds.

Headspace field screening methods require the placement of a uniform volume of petroleum impacted soil in a sealed container with a uniform volume. The volume of soil and headspace should be similar for all soil samples tested to limit variability and enhance comparability of results. Once the soils have been place in a sealed container, they should be warmed consistently to a temperature between 80 and 100 °F to vaporize the volatile organics present in the soil. A calibrated detection devise should be used to quantify the vapor phase hydrocarbons present in the container headspace.

2.1.4 Colorimetric Wet Chemistry

Colorimetric test methods employ visible monitoring techniques to identify and quantify the presence of petroleum hydrocarbons. The methods require visual observation and quantification using visual comparison or spectraphotometric equipment. These methods usually employ organic wet chemistry techniques for determination of petroleum hydrocarbons on a qualitative, semi-quantitative, or quantitative basis.

Colorimetric wet chemistry methods require mixing of soil containing petroleum hydrocarbons with coloring reagents. The presence of petroleum hydrocarbon mixtures are then determined through visible wavelength spectrophotometry or by visual observance of color in the reaction vessel.

2.1.5 Physical Screening Methods

Physical screening methods are qualitative and provide only basic information related to the presence or absence of petroleum hydrocarbons in soil. These methods employ simplistic physical reactions for testing.

Physical screening methods require little or no preparation prior to a direct visual observation to evaluate the presence of petroleum hydrocarbons.

2.2 Field Screening Method Selection Criteria

All field screening methods use different technologies to measure or respond to the presence of petroleum hydrocarbons. These methods can react differently under similar conditions. To select a field screening method that will provide the user with the desired results, several criteria must be considered and evaluated during the selection process. These criteria include:

- Determination of the target analytes (volatile, semi-volatile, or relatively non-volatile petroleum hydrocarbons),

- Estimation of the target analyte concentration ranges (generally comparable to applicable cleanup standards),
- Determination of the data quality objectives, such as the need for quantitative, semi-quantitative or qualitative data,
- Required expertise to perform the screening analysis, and,
- An understanding of the capabilities and limitations of the screening methods.

Each of these criteria is discussed in greater detail in the following sections.

2.2.1 Target Analytes

Each field screening method has been designed to respond to various petroleum hydrocarbon mixtures or classes of organic compounds. Some screening methods are capable of testing for volatile organic mixtures, while others are capable of measuring higher molecular weight petroleum hydrocarbons. To select an appropriate field screening method, the user must first identify the petroleum hydrocarbon mixture in the soil being tested. This is typically ascertained using fixed laboratory analyses and/or prior knowledge of the source of contamination. Samples of the affected soil can be collected and analyzed for the three State of Alaska hydrocarbon ranges to evaluate the relative concentration of GRO, DRO, and RRO. Prior knowledge of from personnel responsible for past site activities and operations should be consulted to determine potential contaminants of concern. Using a combination of site knowledge and laboratory analytical results, the presence of one, or more, contaminants of concern can be determined. This information can then be directly applied to the field screening method selection process.

The presence of multiple petroleum hydrocarbon mixtures complicates the use of field screening methods. The field screening methods are based on the detection of a variety of hydrocarbon mixtures or a combination of the typical State of Alaska ranges (GRO, DRO, and RRO). Without knowing which petroleum hydrocarbon mixture or mixtures are present, a field screening method cannot be selected to adequately estimate or quantify concentrations. If a field screening method is selected without this knowledge, the data generated will likely not be usable for its intended purpose. Additional expense will then be incurred to repeat potentially expensive site activities or correct problems caused by use of biased screening results.

Petroleum Hydrocarbon Ranges

Field screening methods are not capable of generating results that correspond directly to the analytical methods required by the state of Alaska for gasoline range organics (GRO), diesel range organics (DRO), or residual range organics (RRO). Instead, the field screening methods are capable of detecting or quantifying multiple ranges, or varying portions, of these hydrocarbon mixtures. The user should be familiar with information provided by various equipment and test kit manufacturers to ensure the selected screening method will evaluate the desired petroleum hydrocarbon ranges or mixtures.

Aromatics and Aliphatic Compounds

Field screening methods are not capable of independently or accurately determining the aromatic and aliphatic fractions of GRO, DRO, and RRO. However, the use of one or more screening methods in conjunction with certified laboratory analysis may allow the user to estimate the concentration of these constituents at individual project sites. The volume of laboratory and field screening data required to calibrate the response from a field screening method to the total, aromatic, and aliphatic petroleum hydrocarbon concentrations present in soil should be based on sound statistical practices.

2.2.2 Target Analyte Concentration Ranges

Field screening methods have limitations concerning the applicable ranges of concentrations they can detect. Additionally, the concentration ranges are different for each field screening method. The screening method user should identify project specific data quality objectives and identify the field screening method that can meet those objectives.

2.2.3 Data Quality Objectives

Data quality objectives (DQOs) are essential to the process of selecting the appropriate field screening method. DQOs are project specific and are generally established to satisfy project and regulatory requirements. Target analytes, minimum detection limits, methods of quantification/determination, precision, and accuracy requirements are all important DQOs that need to be identified and incorporated into the field screening method selection process. For the purpose of this report, DQOs collectively describe data requirements in terms of quantitative, semi-quantitative, and qualitative data.

2.2.4 Required Training and Expertise

Operation of the various field screening methods requires different levels of personnel training and expertise. Some of the simpler field screening methods can easily be completed after reviewing general procedures and becoming familiar with the operation of instrumentation and equipment. Other field screening methods require various levels of training and/or support from experienced personnel, test kit manufacturers, and trained chemists. It is important that the operator of direct reading instrumentation, test kits, and field-adapted laboratory equipment fully understand the principles used to measure and quantify target analytes. This knowledge allows the operator to maximize the reliability and usability of the data being generated.

2.2.5 Capabilities and Limitations

To select an appropriate field screening method it is important to know the specific capabilities and limitations of the various methods. When selecting a field screening method, it is important to consult with the equipment/method manufacturers to further investigate the capabilities and limitations for application to particular projects. Various factors affecting the applicability of each field screening method are listed below, along with an example of the limitation.

- ***Moisture in soil*** may dilute sample extracts causing low bias or interference with the operation of direct reading instruments. This may result in erroneous data.

- ***Natural organic matter*** in the soil may bias screening results due to the contribution of organic compounds similar to those present in refined petroleum hydrocarbons of concern.

- ***Soil types*** may interfere with testing procedures and results. One example is moist, dense, plastic, clay that is not easily broken apart. In this example, the generation of headspace hydrocarbon vapors for monitoring using a direct reading instrument is limited. Organic peat lithologies will introduce significant quantities of natural organics causing high bias in immunoassay screening results. Gravel and rock lithologies decrease the accuracy of all screening methods due to limited sample surface areas, increased sample mass, and the limited sample size required by most screening methods.

- ***Low temperatures and high altitudes*** may limit or preclude the operation of some direct reading instruments.

- ***Temperature fluctuations*** may alter the response from field screening instrumentation and equipment requiring frequent calibration.

- ***Electrical power source stability*** is required for operation of some field screening method equipment. Continuous power with limited voltage and current fluctuations is typically required when using electrical equipment requiring an alternating current (AC) power supply.

2.2.6 Other Technology Selection Criteria

Other field screening method selection criteria include the following.

- ***Logistical concerns*** require attention when shipping United States Department of Transportation (USDOT) hazardous substances such as methanol, hexane, isobutylene, or other chemicals or compressed gases to project sites. Some immunoassay methods require low temperature preservation during shipment and storage prior to use.

- ***Timeframe for testing*** must be considered. Some of the field screening methods will allow the user to test hundreds of samples per day, while others will be limited to fewer than 40.

- ***Cost*** will play an important role. The number of samples to be tested and the usability of the data will have a direct bearing on cost feasibility. It is suggested that the user perform a cost benefit analysis prior to selecting field screening methods.

3.0 SELECTING APPROPRIATE FIELD SCREENING METHODS

3.1 Field Screening Methods Guidance

Field screening methods were designed to provide users with a relative estimate of petroleum hydrocarbon concentrations or an indication of the presence or absence of petroleum hydrocarbons. As described above, field screening methods are subject to multiple factors and conditions that can affect the results they generate. Selecting an appropriate field screening method is a multi-step process requiring a basic understanding of technical, site specific, logistical, and other considerations identified below.

Technical Considerations

- Target Analytes
- Concentration Range
- Data Quality Objectives (DQO)

Site Specific Considerations

- Soil Lithology
- Soil Moisture
- Climate

Logistic and Other Considerations

- Transportation
- Cost
- User Friendliness or required training
- Waste Generation
- Time

The selection process begins with the knowledge of target analytes and the establishment of DQOs. Some field screening technologies are suited for general detection of petroleum hydrocarbons while others are designed specifically for petroleum hydrocarbon quantification. The user of any field screening method must understand their field screening data needs before the most appropriate field screening method can be selected. It is important to understand the following:

- if more than one petroleum hydrocarbon mixture is present,
- if the petroleum hydrocarbons being measuring result from a recent release, or if they are highly weathered, and
- the desired concentration or concentration range for the target analyte.

Because of the multitude of technical and logistical variables influencing selection of the most appropriate field screening method, clear-cut guidance is difficult to convey. However, general guidelines, when followed, will yield defensible arguments for using specific petroleum hydrocarbon screening technologies in the field.

Table 1 provides general information for each field screening method category described in Section 2 of this guide. Table 1 should be used as a preliminary or initial guide to select the field screening technologies or categories that meet your site specific target analytes, DQOs, and approximate concentration ranges you wish to evaluate.

Once the selection criteria in Table 1 are understood, Table 2 can be used to identify the field screening method category or categories most appropriate for your site. Table 2 further elaborates on the technical and logistical criteria important to selecting a field screening method. Factors affecting accuracy and precision are noted for each category. A relative comparison of the training and desirable expertise for the field operator is noted. General causes of interference and the associated effects on the screening results are described for each category. Finally, other logistical considerations such as, waste byproducts, transportation, storage, and shelf life are briefly compared. The task of selecting “the best fit” field screening method can be difficult and is dependent upon site specific technical and logistical data.

It is important to remember that for each screening method category cited in Tables 1 and 2, there likely exists several sources of field screening equipment, methods, or test kits. For example, there are numerous companies that manufacture and sell petroleum hydrocarbon immunoassay test kits. Each manufacturer currently uses similar methods, but different techniques to detect and measure petroleum hydrocarbons. These differences may be important to you when selecting a field screening technology for your site.

A cost benefit analysis should be performed to compare use of selected field screening methods against one another to assure the most appropriate method is selected for your specific site. Also, compare the project cost using the selected method to costs that would be incurred by submitting all samples to a certified laboratory for analyses. It is critical that the use of field screening methods is financially and technically justifiable.

3.2 Quantitative Decision Matrix

A quantitative decision matrix is a valuable tool for making decisions when multiple variables are an issue, such as the example presented by comparing and selecting a field screening method. A simplified example of the quantitative decision matrix is provided in Tables 3 and 4. For complex and large projects, it provides the basis for a cost benefit analysis as recommended above.

4.0 FIELD SCREENING RESULTS

As indicated previously, field screening results do not usually correlate directly with laboratory analytical results. This difference between field screening and laboratory analytical results is attributed to several conditions, which include,

- the inability of the field screening method to quantify the true target analyte (i.e. screening headspace volatile organics to determine RRO soil impacts),
- the presence of multiple refined petroleum hydrocarbon mixtures,
- testing for weathered petroleum hydrocarbon mixtures using methods designed to measure non-weathered petroleum hydrocarbon mixtures (loss of low-molecular weight volatile organics),
- affinity of the soil for petroleum hydrocarbons,
- heterogeneity of the soil lithology or the presence of large gravel and rocks; and,
- the presence of interfering materials (peat, other organic materials, waste, debris, etc.).

Section 4.0 of this general guidance document describes the use field screening data.

4.1 Data Use Summary

Field screening methods are limited by technology, applicability, and cost effectiveness. The intended use of the screening methods is to ascertain a relative petroleum hydrocarbon concentration or to determine presence/absence of petroleum hydrocarbons on a real time basis. This information is needed in the field to make decisions on soil excavation, placement of soil borings and monitoring wells, and sample collection during assessment and remediation of subsurface petroleum hydrocarbons. The data generated by a field screening method is not intended to replace laboratory analytical results. The data should be used to augment laboratory results and for comparison following appropriate interpretation and correlation.

4.2 Precision and Accuracy

The precision (reproducibility) and accuracy (relation to true value) of the quantitative, semi-quantitative and qualitative field screening methods does not generally meet the standards established for certified laboratory analytical methods. However, results from some of the quantitative field screening methods may be comparable to certified laboratory analysis. In contrast, the precision and accuracy for the semi-quantitative and qualitative field screening methods are generally of lower quality.

4.3 Comparability with Laboratory Analytical Results

Interpretation of field screening data requires the user to record and track those items that can bias the results generated by the method. The amount of dilution by soil moisture and high bias resulting from the presence of organic material in a sample should be determined with each group of similar samples so the user can anticipate the bias affecting the screening data.

After basic field screening data trends have been identified, it may be possible to calculate a general response factor that can be used for crude comparisons of the field screening results to laboratory analytical results. One or more response factors can be calculated to adjust the field screening result for this comparison. To calculate a response factor, divide the laboratory results by their corresponding field screening results. Doing this for multiple samples allows the user to determine an average response factor to estimate a comparable laboratory analyte concentration when multiplied by field screening results. Since the precision and accuracy associated with the field screening data is typically worse than those of laboratory analytical results, this method often yields response factors with unacceptable statistical validity. To improve the statistical validity of this approach, multiple soil samples having similar properties (e.g. soil moisture and organic matter) should be used to calculate multiple response factors. The mean and standard deviation from the mean should be determined for the response factor. The standard deviation and standard error should provide the user with an understanding of the inherent error in correlation. Adjustments can be made to the response factor for soils with properties that bias the field screening results.

Due to the difficulty identifying factors that can bias field screening results, it may not be possible to correlate field screening data with laboratory analytical results. Alternate screening methods or additional laboratory analyses may be required to identify factors causing bias. If these factors cannot be identified, the field screening methods should be discontinued and samples should be submitted to a certified laboratory to determine the actual concentration of the target analytes.

5.0 RECOMMENDED FIELD SCREENING PRACTICES

Field screening testing practices should be similar to analytical laboratory practices to ensure data quality. Field screening results should be used in conjunction with certified laboratory analyses. Field screening results should be calibrated by comparison to certified laboratory data to generate statistically valid response factors for each target analyte. The response factors can then be used in the future to augment the field screening results for comparison to certified laboratory data.

Environmental professionals performing field screening of soil samples must understand the test procedures being used and obtain adequate training to allow competent operation and generation of representative screening results. For operation of some of the more complex field screening methods, on the job training is recommended to ensure thorough training of qualified personnel.

5.1 Sample Collection and Homogeneity

Sample collection should be completed in accordance with field screening method manufacturers' specifications or in accordance with the sampling protocols required by similar laboratory analytical methods.

Samples containing weathered diesel and residual range hydrocarbons should be mixed to homogenize the soil prior to testing and prior to submitting to the laboratory for comparative analysis. Mixing should not be performed on samples collected for volatiles analysis. The samples collected for field screening and comparative laboratory analysis should be uniform and have similar properties. Samples should be refrigerated at a temperature between 0°C and 4°C to minimize loss or degradation of the target analytes.

5.2 Holding Times

Field screening samples should generally be tested within a few hours following collection. Samples that cannot be analyzed immediately should be tested as soon as possible or should be extracted and stored within the holding times specified by comparable laboratory analytical methods. The reliability of field screening results is dependent upon the integrity of the samples.

5.3 Quality Assurance/Quality Control

To evaluate the integrity of the field screening sample results, quality assurance/quality control (QA/QC) samples should be collected and analyzed. The field screening QA/QC samples may include calibration verification samples, method blanks, trip blanks, and duplicates.

Calibration and Calibration Verification Samples

The quantitative and semi-quantitative field screening methods typically require calibration to quantify petroleum hydrocarbons. Calibration should be completed in accordance with the screening method manufacturers' specifications. Calibration verification samples are often used to verify that the screening method remains in control during the soil sample testing. Calibration verification samples should also be tested at the frequency specified by the manufacturer and meet method specific acceptance parameters.

Method Blanks

Method blank samples are used to verify the integrity of the test methods and to ensure cross-contamination does not occur during testing. Method blanks do not contain target analytes and target analytes should not be present in method blank samples. The frequency for analysis of the method blank samples is dependent upon method specifications and the judgement of the qualified person performing the testing. If cross-contamination is suspected, a method blank should be tested to determine if corrective measures are required for continued use.

Trip Blanks

Trip blanks are used to ensure samples are not cross-contaminated during shipment from the collection location to the testing location. These samples are only submitted with samples being tested for volatile organic compounds and should be used with the quantitative field screening methods.

Duplicates

Duplicate samples are used to evaluate the precision of field screening method results. One duplicate sample should be tested for every 20 field screening samples collected. The duplicate and original sample results should be reviewed for comparability and results should be within the field screening method requirements specified by the manufacturer.

6.0 LIMITATIONS

The information provided in this guidance document is based on the completion of a field screening methods evaluation, which was limited in scope and cost. Field screening methods are continuously being developed, modified, and marketed to the public. Field screening methods generally provide data that will not compare directly with fixed laboratory analytical results generated using state of Alaska analytical methods for GRO, DRO, and RRO quantification. Field screening methods should be used by qualified and trained individuals who understand their capabilities and limitations. For these, and other reasons, the information provided herein should be evaluated and verified during the field screening method selection process. Any discrepancies should be clarified before final selection is completed.

TABLES