Practical guidance on technologies for field-screening hydrocarbons and associated metals in soil and water

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PRACTICAL GUIDANCE ON TECHNOLOGIES FOR FIELD-SCREENING HYDROCARBONS AND ASSOCIATED METALS IN SOIL AND WATER

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EXECUTIVE SUMMARY

A wide variety of field screening technologies exists for assessing contamination of soil and water with hydrocarbons and associated metals. These technologies range in complexity from simple, qualitative indicators through to advanced, quantitative measurements. This document provides practical guidance to field screening technologies for rapidly assessing hydrocarbon and metal contamination in soils and water. The guide is based on currently available techniques, with reference to the scientific basis, reliability, detection limits and precision of the methods and instruments concerned. The document outlines how to select an appropriate technique according to circumstances, and how and when this is best deployed. It also explains the limits and restrictions of available technologies and any quality assurance measures that should be put in place to verify field-based data.

After introducing the topics covered, the document briefly gives guidance on field sampling and monitoring methods and provides direction to the relevant later parts of the guide. The physical and statistical basis of sampling is described for each medium.

The document describes all field testing and screening methods found in an extensive review of peer reviewed, grey and marketing literature and a person-to-person survey. The methods are categorised into generic classes and a basic overview of operating principles is given. The strategy for selecting an appropriate analytical technique is described, based on the target analytes, estimation of the concentration range, data quality objectives (quantitative or qualitative), the required level of operator expertise, the capabilities and limitations of the screening methods, and cost-benefit factors. Much of the material is presented in tabular form for easy reference.

The findings are integrated in flow charts to facilitate a clear decision making process for field-based technical staff. The flow charts are separated by contaminant type (hydrocarbons/associated metals), the matrix to be analysed (soil/water), and the characteristics of the technology (sensitivity, specificity, ease of use, time of analysis, cost and reliability). Five flow charts are given, structured in a simple stepwise sequence, based on decision boxes, to allow the most appropriate technology to be selected. The master flow chart leads to four subsidiary flow charts for soils, water, hydrocarbons or metals. The flow charts lead to a recommended method.

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1 INTRODUCTION

The purpose of this guide is to enable those who wish to undertake field-based screening for hydrocarbons and associated metal contamination in soil and water, to do so from a more informed position and therefore make more appropriate decisions about which methods to use in a given situation.

This document is based on information collected from within the industry and from related documentation including scientific publications, trade journals, trade reports and instrument manufacturers' literature. Relevant findings from the Alaska Department of Environmental Conservation (ADEC) who undertook a comprehensive review in 1999 of field screening methods used to determine petroleum hydrocarbons in soil are included (ADEC, 1999). However, it should be noted that commercial availability as well as developments in technology have occurred since the publication of the ADEC review, which is accounted for in this report. The information has been gathered from a global source but is pertinent to the UK industry.

The use of trade names is for descriptive purposes only and should not be interpreted as any form of product endorsement.

1.1 BACKGROUND AND DEVELOPMENT OF FIELD SCREENING TECHNOLOGIES AND MONITORING – OBJECTIVES AND BENEFITS

Field screening methods offer a cost- and time-effective means of defining levels and distribution of hydrocarbon and associated metal contamination in soil and water on-site, before undertaking more costly off-site laboratory chemical analysis (Barnes, 2009). That is, it provides a means of undertaking, in real-time, an initial survey of contamination across a site that can be used to inform a more strategic sampling campaign in which more accurate field representative samples for laboratory analyses can be efficiently targeted for collection.

There is a wide range of field screening methods and techniques. None of the techniques measures the entire range of petroleum hydrocarbons or metals. The range of petroleum hydrocarbons or metals detected depends on the samples and analytical method used. Therefore, choosing which method to use is an important process to enable effective screening for hydrocarbon and metal contamination in soil and water. In order to select an appropriate technique it is important to have an understanding of hydrocarbons and associated metals. A brief description of the range of hydrocarbons and metals associated with hydrocarbons is given in Annexes A and B

It is also important to understand the type and quality of data that will be generated by field screening technologies, and interpretation of the data generated should be carefully evaluated before conclusions are drawn (ADEC, 1999). Depending on which method(s) is used, it is possible to achieve qualitative, semi-quantitative and quantitative results using field screening methods. In some cases, the accuracy of field screening technology is approaching that achievable only previously from laboratory analysis. However, laboratory analysis may still be required in order to attain legally recognised measurements. Nonetheless, it is also pertinent to remember that laboratory methods may themselves be subject to error, to which screening techniques are calibrated, with associated errors.

Field measuring and screening equipment range from simple colorimetric test kits to sophisticated portable versions of laboratory instrumentation. Most of these approaches are based on standard methods.

This guidance document:

– Reviews current technology.
– Suggests a classification of field screening methods based on fundamental operating principles.
– Indicates the scope and applicability of different methods.
– Provides a basis for selection of appropriate screening tools based on decision support charts.
– Outlines the limitations of the various approaches.

Thereby, it helps to ensure an appropriate, cost-effective and efficient deployment and sampling strategy. Table 1 signposts the relevant techniques. It needs to be noted that some techniques may fall into more than one category.

Table 1 Summary of field screening methods

Data	Method	Measure-ment	Matrix and contaminant		Page
			Soil*	**Water***	
Qualitative (presence or absence)	Detector tubes	Direct	VOC/ SVOC	VOC/ SVOC	16
	Flame ionisation detectors (FID)	Direct	VOC/ SVOC	VOC/ SVOC	17
	Photoionisation detectors (PID)	Direct	VOC	VOC	17
	Colorimetric	Direct	SVOC/ Metals	SVOC/ Metals	18; 26
	Ultraviolet (UV) fluorescence	Direct	SVOC	SVOC	20
	Laser-induced fluorescence (LIF)	Direct	VOC/ SVOC	VOC/ SVOC	21
	Physical screening		SVOC	SVOC	25
Semi-quantitative (order of magnitude and/or specific compounds)	Detector tubes	Direct	VOC/ SVOC	VOC/ SVOC	16
	FID	Direct	VOC/ SVOC	VOC/ SVOC	17
	PID	Direct	VOC	VOC	17
	Colorimetric	Direct	SVOC	SVOC	18; 26
	Fibre Optic Chem sensors	Direct	VOC/ SVOC	VOC/ SVOC	23
	Immunoassay	Direct	SVOC	SVOC	24
	Gold nanoprobe detection	Direct		Metals	27