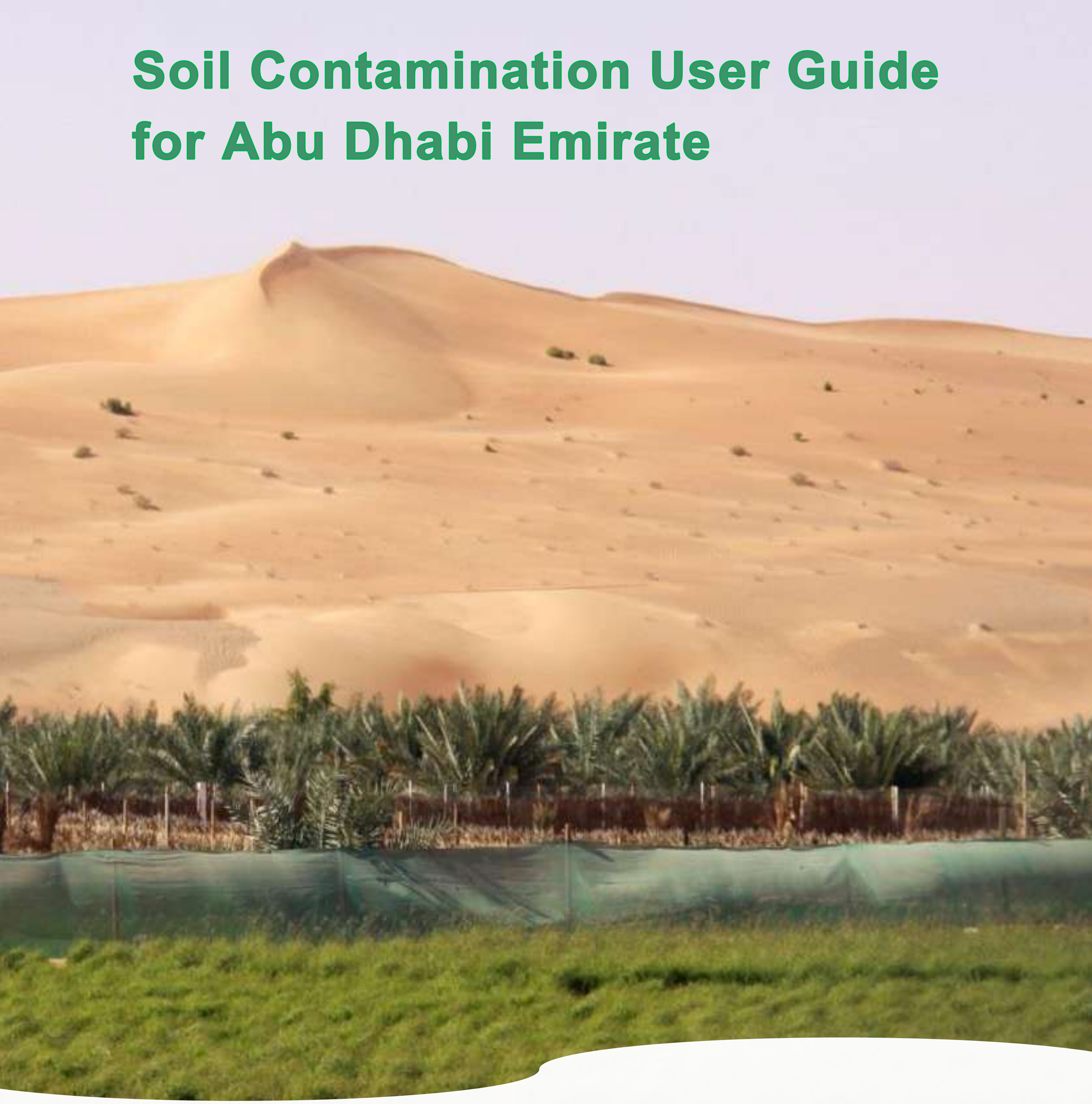
هيئة البيئة - أبوظبي
Environment Agency - ABU DHABI

Soil Contamination User Guide for Abu Dhabi Emirate



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Abbreviations and Acronyms

ACM	Asbestos-Containing Materials
ADNOC	Abu Dhabi National Oil Company
ASLP	Australian Standard Leaching Procedure
ASS	Acid Sulphate Soils
CEMS	Continuous Emissions Monitoring Systems
COC	Chain Of Custody
CPT	Cone Penetrometer Testing
CSM	Conceptual Site Model
CWM	Center of Waste Management
DQO	Data Quality Objective
DSA	Detailed Site Assessment
EAD	Environment Agency-Abu Dhabi
ECD	Electron Capture Detector
ENEC	Emirates Nuclear Energy Corporation
EQL	Estimated Quantitation Limit
EQS	Environment Quality Sector of EAD
FID	Flame Ionization Detector
GC	Gas Chromatography
GPS	Geographic Positioning System
LIF	Laser Induced Fluorescence
LNAPL	Light Non-Aqueous Phase Liquids
LOR	Limit Of Reporting
MDL	Method Detection Limit
MIP	Membrane Interface Probe
MoCCE	Ministry of Climate Change and Environment
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PID	Photo-Ionization Detector
PQL	Practical Quantitation Limit
PSA	Preliminary Site Assessment
QA	Quality Assurance
QC	Quality Control
% R	Percent Recovery

RP	Remediation Plan
RPD	Relative Percent Difference
SD	Standard Deviation
SMP	Site Management Plan
SOP	Standard Operating Procedure
SRN	Sample Receipt Notification
SRV	Site Remediation and Validation
SVOC	Semi-Volatile Organic Compounds
TCLP	Toxicity Characteristic Leaching Procedure
TGD	Technical Guidance Document
UAE	United Arab Emirates
USCS	Unified Soil Classification System
US EPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UV	Ultra Violet
VOCs	Volatile Organic Compounds
WHO	World Health Organization
XRF	X-Ray Fluorescence

Definitions

Competent Authority	The Environment Agency – Abu Dhabi is the competent authority for the Emirate of Abu Dhabi responsible for environmental affairs
Conceptual site model	A representation of site-related information regarding contamination sources, receptors and exposure pathways between those sources and receptors
Contaminated land persons database	A database maintained by EAD of suitably qualified and experienced persons and investigation managers
Clean-up levels	The levels of contaminants which are based on an increased risk of cancer of 1 in 10,000 and a hazard quotient of 10. This is the upper limit of risk generally accepted by international agencies
Emirate	Abu Dhabi Emirate
Screening levels	The levels of contaminants which are based on an increased cancer risk of 1 in a 100,000 across the population which is agreed internationally as an acceptable level of risk
Suitably qualified person	A member of an approved professional organization, has tertiary qualifications, is independent, applies good professional practice, and will report against EAD contaminated land guidelines and has a minimum of one year experience

1 Introduction

The Abu Dhabi Emirate is the largest of the seven Emirates of the United Arab Emirates (UAE) and has, within its boundaries, a diverse range of commercial and industrial enterprises. These enterprises contribute significantly to the ongoing economic development which is occurring within the Emirate. It is also recognised that these enterprises require a wide range of raw materials in their processes and generate a number of waste products which need to be processed and disposed of in an environmentally safe manner. These processes can result in adverse impacts on soils and groundwater under the site.

The Environmental Quality Sector (EQS) of the Environment Agency-Abu Dhabi (EAD) has recognised the need for the establishment of the soil contamination user guide and guideline values which are relevant to the Abu Dhabi Emirate. The user guide has been prepared following the review of relevant international and national publications. Where a prime source was used in a particular section, that source has been acknowledged at the beginning of the section.

1.1 Purpose and Objectives

Numerical values for levels of contaminants in soil that are protective of human health, and the methods used to derive them, are important tools in assessing contaminated sites. Without these values and methods, practitioners are not able to consistently assess the effects of contaminants on human health. Typically, practitioners in the Emirate have previously relied on some international guidelines from which to select numerical values for decision- making. However, these guidelines use different methods for deriving numerical values, have varying levels of risk associated with them and may have been derived for use in soils with different soil properties which may not be appropriate for use in the Abu Dhabi context.

The objective of the user guide and the incorporated guideline values is to ensure that sites affected by contaminants are appropriately identified and assessed and, if necessary, remediated or the contaminants contained to make the site safe for human use. Development of the soil user guide and guideline values has the ultimate aim of defining contamination, how to manage it and also provides requirements for remediation.

The user guide proposes two types of guideline values:

- Concentrations of contaminants that do not pose a risk to human health and where remedial action is not required.
- Concentrations of contaminants that may pose a risk to human health or agriculture and trigger remediation and/or management actions.

The user guide incorporates applicable land uses currently and in the future. The purpose of this user guide and incorporated guideline values is to:

1. Provide a uniform approach relating to the remediation of contaminated sites;
2. Limit uncertainties about the most appropriate criteria and method to apply in the assessment of contaminated sites; and
3. Provide minimum standards for:
    a. Assessing necessary environmental protection measures for remediation activities;
    b. Sampling and analysis of contaminated areas; and
    c. The sites that do not need to undergo site specific assessment.

1.2 Legal Framework

EAD's authority to implement and enforce environmental law in the Emirate derives from both federal and local laws, conventions and regulations, including Federal Law No. 24 of 1999, the UAE's comprehensive environmental statute, and Abu Dhabi Law No. 16 of 2005, which reorganized and renamed EAD. These laws provide several key principles and structures related to soil quality.

Federal Law No. 24 establishes the role of the competent authority in each Emirate, including EAD in Abu Dhabi, in cooperation with the federal Ministry of the Climate Change and Environment (MoCCE) to carry out federal environmental law, as summarized in the following table.

Table 1: Summary of the most relevant environmental regulations in UAE

Legislation	Date	Tile/Description	Project Application
Federal Laws			
No.24 / Executive Orders	1999	Protection and Development of the Environment	This law aims at the protection and conservation of the quality and natural balance of the environment. Applicable requirements to the project include: • Pollution from land sources (Articles 35-38) • Water resources (Articles 17-41) • Soil protection (Article 42-47) • Air pollution (Article 48-57) • Handling of hazardous substance and waste and medical wastes (Article 58-62) • Liability and compensation for environmental damages (Article 71-90)
No.11 and its Executive Order No.22 of 2003	2002	International Trade in Endangered Species of Wild Fauna & Flora	Regulation and control of international trade in endangered species of wild fauna and flora
No.6	2009	Nuclear Law	Control of the use of radioactive sources and protection against its hazards “NORM”
Local Laws			
No.16	2005	Concerning re-organization of the Environmental Agency-Abu Dhabi (Replaced Law No.4 of 1996 as amended)	Establishes EAD and designates EAD as the competent authority to represent the Emirate of Abu Dhabi for the purpose of implementing federal environmental laws and associated executive orders and regulations
No. 21	2005	Waste Management in Abu Dhabi Emirate	Set the requirements for handling all types of waste by parties generating waste and /or operating in the field of collection, transport, storage, recycling, processing and disposal of wastes
Council of Ministers			
Decision No.37	2001	Regulation on Hazardous Substances & Hazardous Wastes	Set the requirements for import, transport, handling and storage of hazardous substances as well as for generation of hazardous wastes and their management and disposal (Articles 5-14)
Decision No.12	2006	Regulation on Protection of Air Pollution	Sets the requirements and limits for emissions from industries and all associated equipment and processes. It sets also the acceptable ambient limits for air and noise quality
EAD Standards and Guidelines			
Standard Operating Procedure (SOP)	2010	SOP for Compliance Monitoring Using Continuous Emissions Monitoring Systems (CEMS)	Sets main air emissions to be monitored by various industries and the allowable limits of various parameters
Technical Guidance Document (TGD)	2011	TGD for Wastewater and Marine Water Quality Monitoring	Sets main parameters to be monitored by various industries and the allowable limits of various parameters

2 Scope of the User Guide

The user guide has been prepared for the use of EAD contaminated land practitioners. The user guide provides guidance in relation to the assessment and remediation of contaminated soil in the Emirate. It provides guideline values for screening the soil to assess whether there is a potential risk to human health or agriculture posed by contamination at the site as well as clean-up levels that can guide the need for remediation.

Guideline values have been derived for the following land uses:

- Residential /open space,
- Commercial and industrial,
- Agriculture

The guideline values quote for contamination concentrations for ***screening levels*** and ***clean-up levels***. ***Screening levels*** are based on cancer risk of (1) in (100,000) across the population which is adopted internationally as an acceptable level of risk. For non-carcinogenic substances the screening levels are based on a hazard quotient of (1). The level of conservatism in these levels means that if the levels of a contaminant at a site are equal to or less than the screening level then the risk to human health or agriculture is low. The site can be developed without remediation action.

The ***clean-up levels*** are based on an increased risk of cancer of (1) in (10,000) and a hazard quotient of (10). This is the upper limit of risk generally accepted by international agencies. Any site where the levels of a contaminant exceed the ***clean-up level***, remediation actions should be undertaken. The type and extent of the remediation required will be determined by conducting a site assessment following procedures outlined in this user guide.

In certain situations more stringent guidelines are required to protect the health of children during sensitive stages of their development. A set of guideline values has been included in this user guide for this purpose. They apply for land uses where children may be exposed to contaminants that are classified by the World Health Organization (WHO) as being known human carcinogens. If these guidelines cannot be met then management actions to reduce exposure must be implemented.

The guideline values given within the user guide are specifically derived to protect human health and agriculture. The values should not be used for the protection of ecological values.

The user guide and associated regulations will only be applicable within the Abu Dhabi Emirate. In coastal areas where both the “Ambient Marine Sediment Quality Limits” and “Soil Contamination User Guide” can apply, the soil contamination guideline values and user guide will apply inland from the low tide mark. Ambient marine sediment quality limits were developed by EAD in 2015 and were adopted on the Emirate level in 2017 for the long-term protection of Abu Dhabi’s marine life and human health.

The user guide does not have jurisdiction within:

- Land or operations under the control of the Union Defence Force or the Abu Dhabi Defence Force; or
- Production areas controlled by Abu Dhabi National Oil Company (ADNOC); or
- Land and operations of the Emirates Nuclear Energy Corporation (ENEC), Barakah nuclear power station.

3 Approach to Site Contamination in Abu Dhabi

The overall process for assessment, remediation and management of contaminated sites is shown in Figure (1):

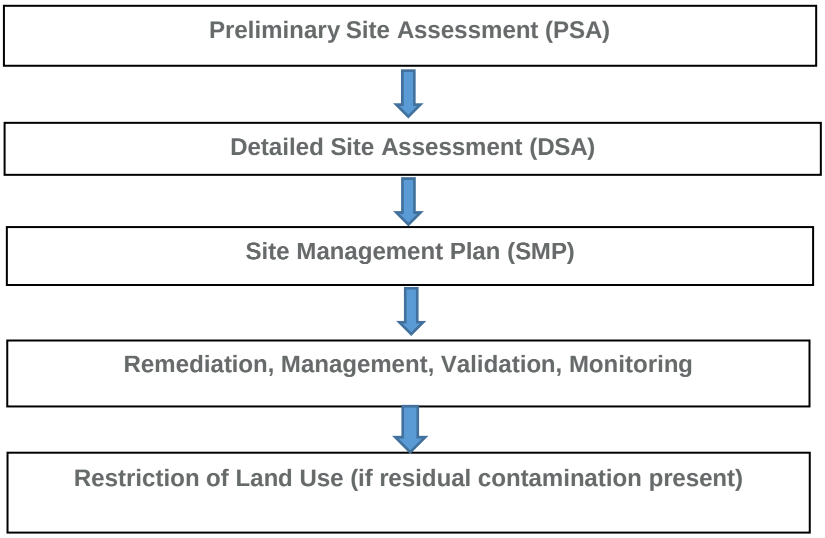


Figure 1: Process for assessment, remediation and management of contaminated sites

The overall process for conducting a contaminated site assessment is outlined below:

1. Identify proposed land use category for the site (residential/open space, agricultural, commercial/industrial).
2. Identify environmental values to be protected relevant to the proposed realistic use of the site. This includes human health and agriculture.
3. Conduct site assessment. The site assessment is usually done in a number of stages:
    a. Preliminary site assessment
    b. Detailed site assessment
    c. Identification of remedial actions (if required)

The key issues associated with contaminated sites are shown in Figure (2).

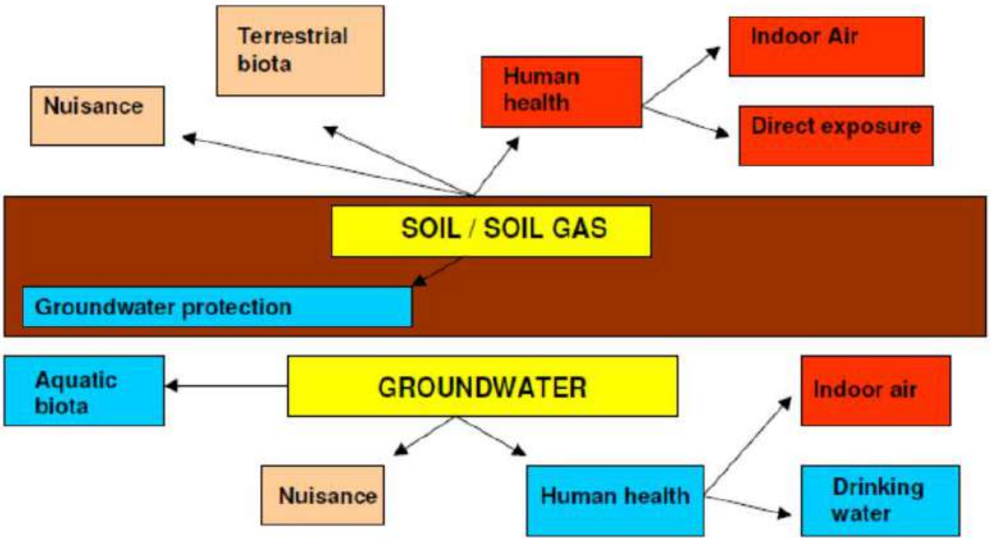


Figure 2: Environmental concerns at a contaminated site

3.1 Development of a Conceptual Site Model

A critical element of any site assessment is the development of a conceptual site model (CSM). The CSM describes the environmental setting, identifies contaminant sources (potential areas of concern and associated contaminants), modes of contaminant movement (migration pathways), the person/ecosystem components/environmental values potentially affected by the contamination (potential receptors) and how exposure may occur (exposure routes).

The development of the CSM is an iterative process, whereby the initial CSM is developed in the first stage of site assessment and revised as more detailed information on the site and the nature of contamination becomes available. The CSM is used to identify risks to human health, the environment and environmental values, as well as uncertainties or critical gaps in information that need to be addressed in subsequent stages.

For exposure to occur, a complete pathway must exist between the source of contamination and the receptor (i.e. complete source-pathway-receptor linkage). Where the exposure pathway is incomplete, exposure cannot occur and hence no risk is present via that pathway under the existing site-specific circumstances. However, the potential for new exposure pathways to be created or completed, for example by a proposed change of land use, should be considered in the CSM. An exposure pathway typically consists of the following elements:

- A source of contamination (e.g. a spill or leak);
- A release mechanism (e.g. migration in soil, leaching to water, emission to air);
- Retention in the transport medium (e.g. soil, groundwater, surface water, air);
- An exposure point (e.g. where a person comes into contact with contaminated dust or soil or contaminated groundwater from a well, or in a building overlying volatile contamination);
- An exposure route (e.g. inhalation, ingestion, absorption through the skin); and
- The CSM should identify complete and potential pathways between the known or potential source(s) and the receptor(s). Where the pathway between a source and a receptor is incomplete, the exposure to chemical substances via that pathway cannot occur but the potential for that pathway to be completed (for example, by abstraction of groundwater or a change in land use) should be considered in the assessment.

The essential elements of an initial CSM are:

- Known and potential sources of contamination and contaminants of concern including the mechanism(s) of contamination (e.g. ‘top down’ spill or sub-surface release from corroded tank or pipe).
- Potentially affected media (soil, sediment, groundwater, surface water, indoor and ambient air).
- Human and ecological receptors.

- Potential and complete exposure pathways.

The presence of contamination may give rise to a number of issues that require consideration. For example, soil contamination may pose a risk to human health through direct ingestion of soil particles or, if volatile, through volatilisation and entry into buildings as vapours. If the contamination is leachable, it may pose a risk through migration via groundwater and exposure where the groundwater is used for drinking or garden irrigation or supports a groundwater dependent ecosystem.

The CSM should include discussion of the following elements:

- The locations of sources and the nature, extent and concentrations of contamination;
- Contaminant migration pathways in air, surface water, groundwater, sediments, soil and dust (a separate report may be warranted for detailed fate and transport assessments);
- Potential receptors and exposure routes; and
- Uncertainties or limitations of the assessment, e.g. conclusions of the data evaluation or areas that could not be sampled because of the presence of infrastructure.

The above information should be discussed in appropriate detail and summarised in a table to clearly identify source-pathway-receptor linkages and risks that require further assessment or management. A graphical CSM, as shown in Figure 3 can also be helpful to illustrate the linkages.

A detailed CSM should include information on the following (on- and off-site as relevant):

- The contaminants: nature of the contaminants identified, concentration, fate and transport, distribution and media in which they occur (soil, water, vapour, sediment or air)
- Physical characteristics of the environment: soil type, porosity, vadose zone thickness, groundwater gradient and velocity and hydraulic conductivity of the saturated zone and the potential presence of preferential migration pathways
- Physical characteristics above-ground: sizes and locations and structures of current or future buildings (if known); potential presence of preferential vapour pathways; nature, size and location of outdoor spaces
- Characteristics of the exposed populations: exposed populations may be people residing or working at the site or off-site areas, future occupiers of the site after redevelopment, or environmental populations such as ecosystems in receiving environments e.g. natural surface waters.

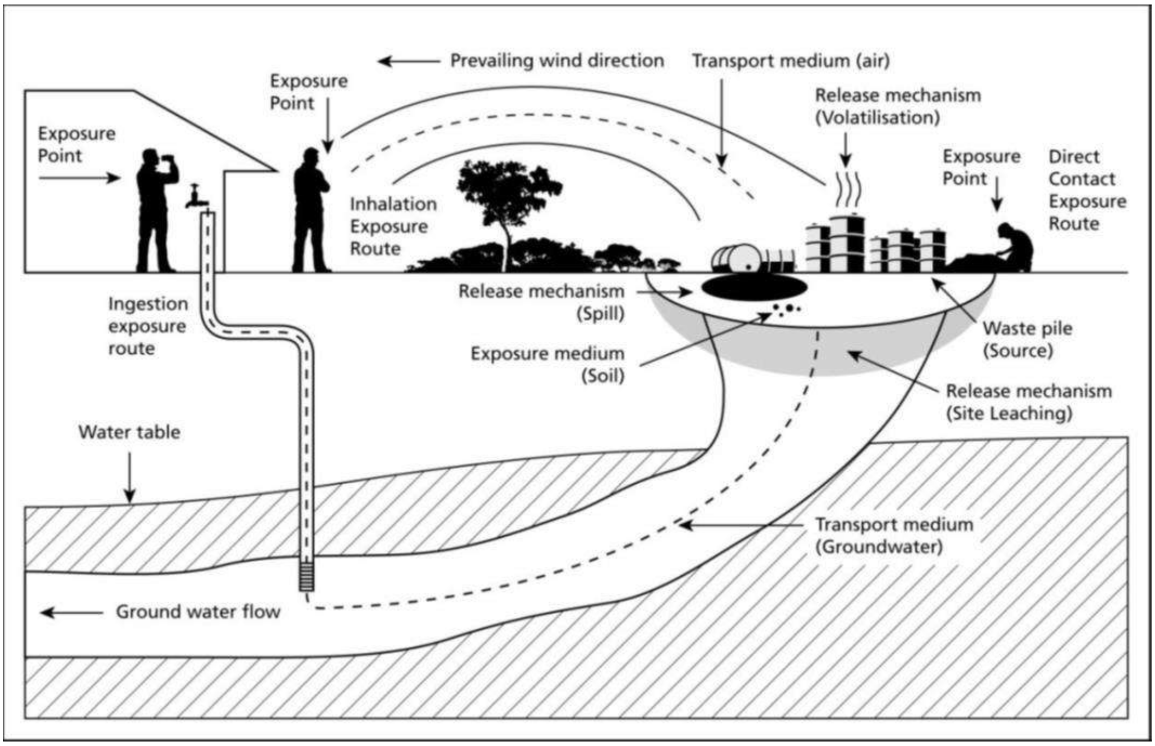


Figure 3: An example of a CSM illustrating potential source-pathway-receptor linkages

The development of a CSM is a dynamic process and it is important that all the information and data from each stage of an assessment are reviewed in an integrated manner (using a multiple-lines-of-evidence approach where appropriate) to refine the CSM and used to inform subsequent decisions on whether further investigation or management is necessary.

The initial CSM is constructed from the results of the PSA and is used to identify data gaps and inform a decision on whether detailed investigation is required. The CSM should be continually challenged and updated throughout the assessment process.

The sub-optimal performance of many remediation systems can be traced back to the failure to undertake adequate site characterisation and to fully integrate the information gained into the CSM. For large and complex sites, 3-D imaging (visualisation) software may be useful for displaying and interpreting the results of the investigations and to refine the CSM.

For the assessment of vapours, additional detail will be needed about preferential pathways for vapour migration and the design of buildings or planned buildings at the site — including the location of sub-surface utilities, foundation construction and condition, and ventilation and heating.

3.1.1 Assessing data gaps and uncertainties in conceptual site models

Data gap identification and uncertainty assessment are key activities in developing and refining a CSM during site assessment. It is, therefore, important that the CSM addresses:

- How representative the available data is likely to be.
- What the potential sources of variability and uncertainty are.
- How important the identified gaps are to the objectives and reliability of the site assessment.

In developing the CSM, the assessor needs to distinguish between variability and uncertainty. Variability arises from true heterogeneity in the environment such as lateral variations in soil properties or lithology or changes in contaminant levels over time and space. Uncertainty represents lack of knowledge about factors, such as contaminant levels (which may be reduced with additional investigation).

The identification of data gaps should be carried out in a logical, structured manner, to facilitate the assessment of uncertainty and the significance of those data gaps to the assessment objectives. Subsequent investigative efforts should be focussed on addressing the critical data gaps in a manner that is proportional to the uncertainties identified and results in data which is representative of the assessment area.

A tool for assessing gaps and uncertainties in CSMs and assessing their level of significance can be found in Clements et al. (2009).

3.2 Preliminary Site Assessment

The purpose of a preliminary site assessment (PSA) is to identify the potential sources of contamination and contaminants of concern, the receptors that may be exposed to contamination and the relevant exposure pathways. The scope of work should be sufficient to provide an initial indication of a site’s contamination status, the nature and location of likely sources and receptors, and to determine whether detailed site investigation is warranted.

The purpose of collecting basic site information is to identify potential contaminants, potentially affected media and potential areas of contamination by reviewing the site history, physical setting including local geology and hydrogeology, and site conditions. The information collected is used to develop an initial CSM of the site (refer Section 3.1).

A site inspection should be undertaken to complement the findings of the desktop study and site history and to identify any additional relevant site information. It is recommended to conduct interviews with current site owners and occupiers and, where practicable, previous site owners and occupiers.

It is essential that the location of the site and the significant features involved in its history be accurately and clearly identified. The PSA report should clearly identify any significant data gaps and include an assessment of the accuracy of the information collected.

A PSA generally comprises:

- Desktop study (records and published information relevant to the environmental setting and site history);
- Interviews with site representatives (for example managers, owners, former employees, neighbours);
- Detailed site inspection(s) and soil/groundwater sampling; data evaluation;

- Development of an initial CSM; and
- Identification of potential risks and any uncertainties or limitations.

Soil sampling as part of a PSA is undertaken if there is sufficient information available to inform the occupational health and safety plan. Sampling of an opportunistic type is sometimes carried out to inform the soil sampling plan for the DSA.

The initial CSM, developed from the findings of the PSA, forms the basis of further site investigations. It is recommended that as much information on the site as possible is obtained and assessed in this phase of investigation. An assessment should be made of the accuracy of the information and any significant data gaps identified. A poor-quality PSA will result in a lack of confidence in the findings of any subsequent investigations completed at the site. For example, a PSA report that does not specifically comment on the presence or absence of bonded asbestos containing materials (ACM) on the land surface where fences may have historically been composed of asbestos, may lead to additional work later on in the assessment.

3.2.1 Potentially contaminating activities

A PSA should include consideration of whether activities carried out at a site have the potential to cause contamination. A list of potentially contaminating activities that should be considered during site assessment is provided in Appendix B. The list is not exhaustive and it may be necessary to consider whether other activities carried out at a site could cause contamination. Potentially contaminating activities carried out on surrounding land should also be considered. It should be noted that a site is not necessarily contaminated solely because an activity listed in this guideline has occurred on the site. A weight of evidence approach should be taken by assessing all available sources of information.

Some sites may have hosted more than one potentially contaminating activity during their history and all such activities should be considered for assessment purposes. For example, ‘Work Depots’ may have had components of fuel storage, asphalt manufacturing/storage, pesticide mixing and vehicle maintenance.

Information regarding the site’s history, such as manifests and inventories, should inform the potential contaminants of concern and this may include chemicals listed in the Abu Dhabi specifications for soil contamination and in the guideline values (see Appendix A). Some chemicals are specifically named in Appendix B—for example, persistent organic pollutants recognised as causing adverse effects on humans and the ecosystem under the Stockholm Convention on Persistent Organic Pollutants (2004). It is acknowledged that some of these substances may not have been used in Abu Dhabi, or may not be currently registered for use in the Emirate. The site history and the CSM should inform whether they need to be considered when planning investigations.

3.2.2 Site identification

The current legal description (real property description, for example, lot number X on plan XX) of all affected land parcels and the street number and name and suburb should be obtained, together with a copy of the current certificate of title. It is also useful to list any common name or description by which the site is or has been known.

Where multiple lots are involved, plans that show lot boundaries in relation to significant features should be obtained. Maps (including street maps), plans or diagrams should be used to clearly identify the location of all affected land parcels in relation to their surrounds, for example, street access, neighbouring property boundaries, parks, local watercourses and any areas of environmental significance.

3.2.3 Current and proposed use

The following details should be obtained:

- Current uses of the site.
- Map and narrative description of proposed use(s) for the site.
- Current land zoning of the site, for example, industrial, mixed commercial, residential, educational.
- Type of proposed use—in the context of the categories described in Section 2 of this user guide.
- Type of buildings proposed and any sub-surface excavation required.
- Density of residential use (if proposed) - high or low.
- Type of users, e.g. residents (adults and children), workers.
- Planning approval(s) for proposed use (and date).

3.2.4 Site history

The history of a site can provide valuable information on the nature and extent of potential contamination and pathways for contaminant migration. A log should be kept of all information sources and the report should include details of all documents reviewed during the investigation of the site history.

A site history should contain, as far as practicable, all available information that assists in identifying the potential nature and extent of site contamination. It may also be useful for identifying features (for example, current and disused utilities) that may act as potential preferential contaminant migration pathways. It may include the use of video or photographic logs to assist with site documentation.

Sources of information for compiling a site history include but are not limited to:

- Past and current owners and occupiers, operators or workers at the site and adjacent properties.
- Local knowledge of residents.
- Current and historical aerial and ground photographs.
- Past involvement with government authorities or consultants (environmental audits, notices etc.).
- Trade and street directories.
- Historical societies or territory government libraries.
- Historical titles back to original deeds.
- Local literature, including newspapers.
- Technical literature, including plumbing and building permits/plans, flammable and combustible liquid storage and handling licences.
- Complaint history and information from environmental licences and trade waste permits held by government departments.
- Geological survey maps and reports.
- Groundwater/drinking water protection zones.
- Groundwater abstraction licences.
- Planning development approval records, sewer and underground service plans.
- Site layout plans.

To compile a site history, the assessor should consider the issues described in the following sections.

Site plan and historical maps and aerial photographs

It is essential to have a locality map and a current plan of the site, with scale bar, indicating the site orientation (including north) and general topography of the property, local water drainage and other environmentally significant features. A review of the site history with dates as deduced from current and historic aerial photographs and other historical information should be included (where available). In addition to historical aerial photographs, other historical maps and plans are at times available and can be of great value (for example, government department maps and plans, local council records, street directories, topographic maps, geological maps, mining maps).

Land Use Zoning

Necessary records include previous, present and proposed zoning, and relevant development and building approval records.

Present owners, occupiers and current users of the site

If these are not the parties responsible for the assessment and management of the site then those who are (or are thought to be) responsible should also be identified if possible.

Previous owners and occupiers of the site

These should be listed chronologically, noting any periods during which ownership or tenancy is unknown or uncertain.

Previous activities/uses

A chronological list of land uses should be compiled, focusing on industrial uses or other potentially contaminating activities, and including any periods during which the land use is unknown or uncertain. While ‘small tannery’ may be seen as an imprecise description, it nonetheless provides some information about the nature, severity and distribution of any potential contamination. Precise industrial capacities of properties should be cited if available. The chronology should include dates when areas of the site were sealed, for example, by concrete slabs, in relation to the occurrence of potentially contaminating activities to prevent unnecessary under-slab sampling, although the potential for the migration of contamination underneath hardstands from adjacent sources will need to be taken into account. Consideration should also be given to uses on adjacent sites that could be a source or receptor of contamination.

Services to the property (including sewer and underground services)

Site plans showing the location, elevation and size of sewers, stormwater drains and underground utilities (such as communications infrastructure) should be included, as these may assist in identification of preferential contamination migration pathways.

Previous and present building and structures

These are generally best illustrated by a series of annotated site maps showing the locations of permanent and semi-permanent structures, offices, sheds, reaction vessels, storage tanks, etc. These should be presented in chronological order to show how the site developed. Key building design features such as the nature of foundations, presence or absence of crawl spaces or basements should also be included. The nature of buildings and infrastructure should be considered in relation to potential occurrence and distribution of asbestos-containing-materials. Where infrastructure has been decommissioned, the site history should note whether any potentially contaminating contents are known to have been removed (for example, whether tanks and pipelines were drained or simply blocked off).

Industrial processes carried out on site and the products manufactured

A list should detail the products from the industries and activities identified as being relevant to the site.

Chemical storage and transfer areas

Locations should be indicated on the scaled site plan and chemicals stored and transferred at each area identified.

Raw materials used

A list of raw materials stored or used at the site should be compiled. Chemicals should be identified by systematic names as well as common or trade names.

Intermediate products

These are important in both batch and continuous production processes. Residual reaction components and intermediate products may have been discharged from reaction vessels prior to production runs. Quality assurance procedures may also have included sampling points from intermediate stages in the manufacturing process which may have been allowed to drain away or be otherwise discarded on site.

Product spills, losses, incidents and accidents (including fire)

These should be listed chronologically, together with an indication of the material spilled, estimates of quantity, extent of fire damage and structures affected.

Discharges to land and water

The types of waste currently and historically discharged should be identified. Where practicable, the quantities should also be established.

Wastes produced

This requires an understanding of the processes being performed in the industries and activities identified above. Wastes may be identified specifically (for example, waste degreasing solvents including carbon tetrachloride) or more generally (for example, acid slurry).

Power generation

Generation of power at some sites may have used solid and liquid fuels requiring fuel storage and disposal of ash. This may have resulted in contamination by fuel and combustion products, for example, polycyclic aromatic hydrocarbons (PAHs). If the power requirement was large, a sub-station with a transformer(s) may have been on site with the attendant risk of polychlorinated biphenyls (PCBs) spills. In addition, fibrous asbestos may have been used for insulation purposes.

Waste disposal locations and imported fill

Locations of solid waste and liquid waste disposal areas and liquid waste lagoons, settling tanks, sumps and soak wells should be identified in the maps and figures described above. The location of any wells on site should be indicated as these may have been used for liquid waste disposal.

Historically, many industrial wastes and diverse contaminated fill were considered a low-cost source of material to level or elevate sites. Wastes may have originated from on-site industrial activities or have been introduced from unknown off-site sources. Residential and industrial/commercial areas around major industries (for example, power stations, and mineral processing plants) may have been filled with ash, coke, hydrocarbon impacted fill, metal waste and various wastes originating from the industrial activity.

Sites should be assessed for areas of fill, particularly if there are reasonable grounds to suspect the original land form has been altered such as has occurred along the coastline of the Abu Dhabi Emirate.

Earthmoving activities carried out on the site

This information will assist in determining the source and location of any imported fill. Consideration should also be given to the possibility that earthmoving activity may have resulted in redistribution and burial of contamination.

Interview information

Interviews with past property or business owners and occupiers and employees should be conducted where practicable. The objective of interviews is to confirm information collected in the desktop study and to gain additional relevant site information (for example, source of drinking water, presence of wells on-site, date of connection to sewer, history of spills and leaks, arrangements for liquid and solid waste disposal, etc.). Owners and occupants of neighbouring properties may also be able to provide useful information.

Sources of information

A log of all sources consulted for site history information should be kept so that the completeness and reliability of the information collected, and hence confidence in the desktop study results, may be assured. Personal recollections and anecdotal records should be cross-checked where possible and any limitations of the information noted. This information should be clearly documented in the PSA report.

A chronology or timeline should be developed of the relevant events to assist interpretation.

3.2.5 Environmental setting

The environmental setting includes the surrounding land uses, soils, geology and hydrogeology, tidal regime, seasonal or climatic conditions or any other feature of the environment that may be relevant to the assessment. The purpose of describing the environmental setting is to identify potential receptors, understand how contaminants may behave in the environment and identify potential off-site sources of contamination. The area that is assessed should be determined based on the likely distances that potential contaminants could migrate (site-specific and contaminant-specific considerations apply). In general, the search radius should take into account the distance that contaminants could migrate to or from the site. A search radius of 500 m from the boundary of the site is suggested as a general guide.

If the site is located in low-lying land, consideration should also be given to whether the site is likely to be located in or affected by acid sulphate soils. Where there is the potential for acid sulphate soils to be present, this should be taken into account when preparing the sampling and analysis quality plan as appropriate procedures are required (see Section 3.3.2).

Local geology and hydrogeology

The local and site-specific geological and hydrogeological settings influence the fate and transport of potential contaminants in the vicinity of and at the subject site.

The distribution of contaminants across a site is influenced by the local geology and natural or man-made/altered drainage features in the area or at the site. Their distribution within the sub-surface is influenced by geological structures, variations in the permeability of soil and rock (which may result in perched water tables), geochemical, biological and mineralogical variations and the presence of preferential pathways such as loose fill around services.

Certain sites may be located in areas that are naturally enriched with mineral resources and can appear to contain elevated levels of metals and metalloids in soil, surface water or groundwater. Consequently, it is essential to have an understanding of the background quality of these media and to evaluate potential contamination of this type of site in terms of the environmental values for the site and its water resources.

The soil/geological/hydrogeological component of the desktop investigation may include review of the following types of published data:

- Surface elevation.
- Regional and site-specific soil and geological records.
- Geophysical data.
- Drilling logs which clearly identify imported and locally derived fill (including refuse) and natural strata.

- Well logs including strata, casing or construction details, and water level, quality and pump/discharge rate information.
- Values for soil bulk density and porosity.
- Soil organic matter content by suitable methodology.
- Cation exchange capacity by suitable methodology.
- Soil pH and redox potential measured in situ.

Given the interaction of contaminated soil and groundwater and the potential for cross-contamination, in addition to information on the soil characteristics information on groundwater needs to be considered. This information should include:

- Aquifer types (unconfined, semi-confined, confined).
- Direction and rate of groundwater flow.
- Regional and site-specific hydrogeological information, including groundwater quality.
- Current usage/resource potential.

For more comprehensive assessments, for example where groundwater fate and transport modelling is to be undertaken, desktop studies may also consider:

- Hydraulic and piezometric heads and hydraulic gradients.
- Hydraulic conductivity.
- Transmissivity.
- Other parameters as appropriate.

3.2.6 Site inspection

A comprehensive site inspection is a critical stage of the site assessment process. It validates anecdotal and historical information and can identify additional evidence of potential contamination. The complexity and detail reported in a site inspection may vary depending on the level of historical information and anecdotal information relevant to the site and the complexity and detail of the site itself.

The site inspection should seek to identify potential sources of contamination, pathways and receptors, confirm the layout of the site and identify constraints to site access for sampling. The site inspection should be used to describe the current condition of the site and validate plans or other information obtained during the desktop investigation, and photographs should be taken for future reference. Where possible, the site inspection should be carried out in the company of a person familiar with the site, for example, the site manager or knowledgeable employee.

The following features, among others, should be noted:

- Current uses of the site and surrounding land.
- Disturbed, coloured or stained soil.
- Bare soil patches.
- Disturbed or distressed vegetation.
- Unusual odour.
- Quality of surface water (if present).
- Sheens on water surfaces.
- Site topography and surface water drainage.
- Presence and type of groundwater wells on the site and adjacent landholdings.
- Condition of groundwater well headworks.
- Measurement of groundwater (water table and/or piezometric) levels.
- Condition of buildings, concrete and bitumen floors and roads, etc.
- Building construction (slab-on-ground or other, presence or absence of crawl spaces and basements).
- The means of heating (fuel type) and cooling buildings on the site.
- Presence or absence of bonded asbestos-containing materials (bonded ACM) on the ground surface
- Presence of stockpiles, fill, containment areas, sumps, drains and waste disposal areas – operational and closed.
- Evidence of cut and fill activities.

- Presence of pits, ponds and lagoons.
- Presence and condition of chemical containers, holding tanks, bunds, etc.
- Presence and condition of any underground storage tanks (USTs) and associated infrastructure.
- Underground structures that may be associated with sub-surface contamination.
- Condition of materials storage and handling facilities and any solid or liquid waste disposal areas.
- Any evidence of on-site spillage of dangerous goods and/or off-site migration.

For operating sites, an inventory of chemicals stored or used at the site and copies of Material Safety Data Sheets (MSDSs), dangerous good licences, operating licences, works approvals and notices, and results of environmental audits should be obtained where practicable.

Any areas of the site that were not accessible or accessed during the site inspection should be noted. Observations should be recorded at the time of the inspection and the information included in the assessment report as descriptive text within the main report body together with a plan of site features and photographs (accompanied by a location and aspect plan). Depending on the nature of the site, it may also be relevant to note the absence of potential contaminants (e.g. asbestos on the site surface) or indicators of contamination.

3.3 Detailed Site Assessment

A detailed site assessment (DSA) involves the collection and evaluation of site-specific data, including the sampling and analysis of environmental media (soil, soil gas, surface water, groundwater, sediment) to characterise the site and the nature and extent of contamination. The information obtained is used to refine the CSM and identify potential or actual risks to human health, the environment or environmental values that require further assessment, and/or remediation. A DSA generally involves:

- Development of project objectives;
- Planning and implementing a soil sampling and analysis plan to meet the project objectives;
- Data evaluation;
- Refining the CSM; and
- Identifying risks and any uncertainties or limitations.

In circumstances where a risk is identified, further assessment and/or remediation will be required, which may involve further desktop investigation, and site investigation.

3.3.1 Preparation for field sampling

An important phase in any contaminated land assessment project is preparing for the field sampling. The type of field work will vary depending on the nature of contaminants being investigated. However, the following check list will help remind investigators of the issues which need to be addressed:

- What permits are required to enter or investigate the site?
- What government/non-government agencies need to be informed?
- Prepare a soil sampling plan (details discussed elsewhere).
- Determine workplace health and safety requirements for sampling staff particularly referencing heat effects (include emergency response protocol).
- Define staffing requirements for the investigation –remember that during summer, staff may have to be rotated (for rest breaks) every 2 -3 hours.
- Select an appropriate laboratory for analysis and collect pre-prepared sample containers.
- Identify what sampling equipment is needed (including external contractors).
- Conform with EAD contractual requirements (if hiring outside equipment).
- Decide on what environmental monitoring equipment should be used and arrange to hire if not available in-house.
- Prepare a Site Safety Induction Program for EAD staff and site visitors.

3.3.2 Field investigations

Contaminated soil can arise from a number of sources, including accidental spillage of chemicals, leaching of contaminants from poorly managed landfills and leakage of chemicals from drums, tanks, pipe-work and drains.

Contaminated sites can potentially pose a threat to human health through the release of hazardous dusts and vapours during any reworking of the soils (such as during redevelopment of a site), through direct contact with the skin, and via ingestion.

Contaminated soils can also potentially pose a threat to groundwater via the leaching of contaminants through the soil profile and through uptake by plants.

Soil investigations generally comprise the installation of soil investigation bores using hand or power driven drilling/excavation equipment to enable the collection of soil samples representative of the soil profile. The soil samples can then be examined and analysed to determine whether adverse impacts have resulted.

Soil sampling at a site can be conducted as part of:

- PSAs to determine if further investigations are necessary;
- DSAs (sometimes undertaken as a series of sampling events);
- Site management plan, for example, remediation progress evaluations; and
- Remediation, validation and ongoing management.

For any of these, a sampling plan may be recommended, especially for large and/or complex sites. Once analytical results have been received, determination of the level of contamination should be made via comparison of results against the guideline values.

3.3.2.1 Factors to be considered in selecting a soil sampling method

In selecting the most appropriate sampling method, the following factors should be considered:

- Knowledge and experience of field staff in sampling techniques;
- Accessibility to the site and/or sections of the site;
- Availability of equipment;
- Nature of contaminant(s);
- Health and safety of site personnel and general public (e.g. exposure to contaminants, potential release of contaminants);
- Anticipated extent of contamination (e.g. hand augers can be used to sample shallow contamination in soft soils, whereas deeper contamination and hard soils may require a back hoe or drilling rig);
- Geological conditions (e.g. type of drilling rig required);
- Hydrogeological conditions (e.g. depth to water table, aquifer type, number of aquifers, groundwater flow direction);
- Potential for vertical and/or lateral cross contamination during and after the collection of samples;
- Sensitivity of samples to potential cross-contamination and degradation in storage;
- Type and volume of wastes produced and waste disposal methods;
- Disturbance of flora/fauna/heritage sites; and
- Potential for release of contamination to the wider environment and surrounding beneficial uses via dust and odours and storm water runoff (if in or close to wadis).

All samples should be collected using appropriate techniques to provide representative and reproducible data.

It should be noted that where underground structures (USTs, pipe-work, bowsers, drainage lines, etc.) remain in situ during any investigations, the results are indicative only. In order to determine a more detailed and accurate representation of contamination, collection of samples from beneath infrastructure is required and this is generally not possible where underground infrastructure remains, and particularly where the site remains operational, as access is often limited. Therefore, any information obtained from sites where infrastructure remains will require validation following decommissioning of the site.

Where the location of an UST and associated infrastructure is unknown, the use of geophysical methods and field-testing should also be considered.

3.3.2.2 Soil sampling locations

Pattern Types

The determination of soil sample locations is dependent upon the characteristics of the site and the contaminants of concern. For all sampling programs, justification for the sample locations chosen must be documented and reported to enable assessment of the results based on the location of sampling points. Where justification is not considered acceptable, particularly where limited sampling has been completed, EAD may require that additional fill in sampling is required prior to approval to move to the next stage of work.

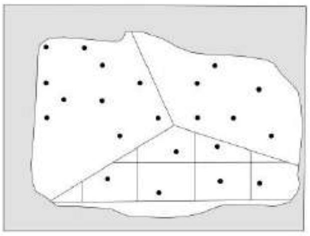
Soil sampling locations should be based on knowledge of the site, and the pattern type could include:

- Judgemental sampling (for areas of known contamination), or for areas with little definite information;
- Systematic sampling (grid pattern);
- Stratified sampling (sampling of sub areas);
- Simple random sampling;
- Stratified random sampling (random sampling within sub areas); and
- Composite sampling (see below for further discussion).

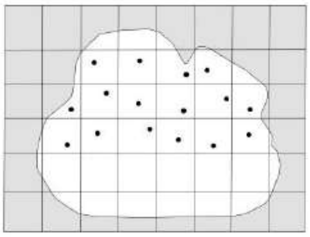
As a general rule, where detailed information is available for the site in terms of physical characteristics, potential contaminants and potential sources of contamination, judgemental or stratified sampling can be applied. For example, some sites, such as former service stations have a known layout of operations and likely distribution of contaminants. Where little or no information is available on potential contamination sources at a site, such as former landfill sites or abandoned industrial sites, then a systematic (grid) pattern of sampling may be more appropriate. However, it is acceptable that sampling types may be combined such as a grid pattern with some judgemental sampling at locations where more information is available.

It is recommended that, where possible, “background” control points be identified to act as a reference point in determining the levels of contamination against pre-existing concentrations.

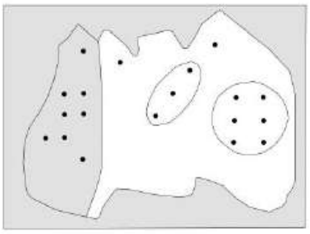
It should be emphasised that the main goals of a sampling plan is to produce data which is an accurate representation of the in situ contamination at a site, therefore a sampling pattern should be applied so as to produce adequate information on the type, location and extent of any contamination. It also means that each site has to be assessed individually as to the most appropriate sampling pattern.



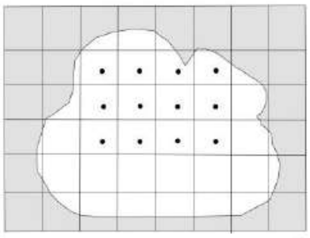
Stratified random



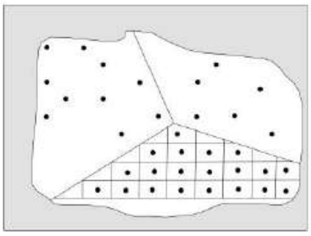
Simple



Judgemental



Systematic



Stratified

Number of Samples

In determining the number of samples to be collected, the following should be considered:

- Findings of the PSA;
- Size of the site, and final subdivided sites (if the site is to be subdivided);
- Sampling pattern applied;
- Depth of investigations (i.e. metre intervals, lithological changes);
- The number of stages of sampling considered feasible; and
- Potential remediation and management options for the site.

If a site is to be subdivided, the size of the subdivided lots should be taken into account when determining the sampling density. While predictions may be made on a 'macro' scale, residents or owners may seek information about their own particular area of land and the risks associated with this land, especially if the potential contamination on the original site was uneven in distribution and type.

The detection of hotspots is an important issue for sites to be used for residential purposes or other sensitive uses where children have regular access to soil or where there is potential groundwater contamination. A greater sampling density is usually required for these sites. The toxicity of the contaminant and the size and magnitude of the potential hotspot(s) needs to be considered in determining the sampling density.

Table (2) provides guidance on the minimum number of samples required in the characterisation of a site with the potential for hot spot contamination.

Table 2: Minimum sampling points required for site characterization based on detection of circular hot spots using square grid

Area of site (hectare)	Recommended number of sampling points	Equivalent sampling density, points/hectare	Diameter of the hotspot that can be detected with 95% confidence, (metres)
0.05	5	100	11.8
0.1	6	60	15.2
0.2	7	35	19.9
0.3	9	30	21.5
0.4	11	27.5	22.5
0.5	13	266	23.1
0.6	15	25	23.6
0.7	17	24.3	23.9
0.8	19	23.8	24.2
0.9	20	22.2	25
1.0	21	21	25.7
1.5	25	16.7	28.9
2.0	30	25	30.5
2.5	35	14	31.5
3.0	40	13.3	32.4
3.5	45	12.9	32.9
4.0	50	12.5	33.4
4.5	52	11.6	34.6
5.0	55	11.0	35.6

Notes for Table (2):

- The guidance in this Table of the number of sampling points does not imply that minimum sampling is good practice for a given site. The investigator should be prepared to justify the appropriateness of applying this Table or any other sampling rationale.
- No guidance is provided for sites larger than five hectares. Such sites are usually subdivided into smaller areas for more effective sampling.
- The minimum sampling is designated to detect a circular hot spot of the prescribed diameter with 95% confidence. The confidence of detection is less than 95% for non-circular shape hot spots. Confidence of detecting circular hot spots of smaller diameter than that prescribed is also lower.

Composite Sampling

A composite sample is made up of a number of constituent samples (sub-samples), which are collected from a body of material and combined into a single sample, which therefore represents the average conditions of the body of material.

The rationale behind the use of composite sampling is often to reduce analytical costs, and to provide a general indication of the presence/absence of contamination in investigation programs. Although in principle, composite samples represent the average concentration of the constituent samples, a major drawback with compositing is that a constituent sample containing a high concentration of contaminant can remain undetected because its concentration was diluted in the compositing process. Conversely, constituent samples may contain lower concentrations than the average, and where the average is above assessment levels, may result in investigation/remediation of areas that are below the assessment levels.

In addition, due to the fact that composite samples do not provide an indication of the possible maximum contaminant concentrations, the results from composite sampling cannot be used for health assessments.

Based on the above limitations, composite sampling is not recommended as a sampling technique within the Emirate.

Sampling Depth

In order to determine the vertical extent of contamination, soil samples should be collected from more than one depth at each sampling location. Where contamination is identified, the maximum depth (where practicable) to which that contamination extends should be determined.

Where soil contamination extends to the water table, samples of both the soil within the saturated zone and groundwater should be collected in order to delineate the concentration of contaminants present in both the soil and groundwater. Where soil samples are collected from the saturated zone they should be clearly identified as such in any reports and documentation.

The determination of soil sampling depths should take into consideration:

- Findings of the PSA;
- Known or potential sources of contamination (e.g. surface spillage or UST(s) and pipelines);
- Depth to groundwater;
- Nature of aquifers beneath site;
- Underlying natural soil/geology (well defined layers or infrastructure trenches/corridors present that would influence contaminant migration);
- Presence of fill horizons on-site;
- Type and nature of contaminants (mobility, persistence);
- Length of time contaminants have been, or may have been, present at a site (which will have a bearing on the lateral and vertical dispersion of contaminants, such as smearing of profiles within a saturated zone, formation of a groundwater contaminant plume, etc.);
- Field observations and identification of contaminated soil (staining, odours); and
- Risk to human health and to groundwater.

Where groundwater is encountered, drilling should continue to a sufficient depth below the static water level, or to a depth where no impact is suspected based on observation and field headspace screening (where applicable).

It may be necessary to increase the depth interval if the volume of soil recovered is insufficient to undertake the required analysis (often the case where duplicate samples are required). This will be directly dependent on the sampling method utilised.

For protection of human health, the soil strata to which people and other receptors could feasibly be exposed should be adequately sampled. This will result in a weighting towards near-surface sampling unless the history or the nature of the soil and the presence of groundwater suggests it should be otherwise. On residential sites, the maximum excavation depth (such as for a swimming pool) is unlikely to extend beyond three metres, but much deeper soil disturbance may occur on a commercial site.

If dealing with volatile contaminants such as light fraction petroleum hydrocarbons or chlorinated solvents, then vapour transport from depth and through a shallow soil zone may pose a risk. Deeper sampling to determine the nature and extent of the source of the vapours and the risk they represent may be required.

To delineate contamination laterally, typically samples should be taken until either no further contamination is detected or concentrations are below the relevant investigation levels.

The nature and appearance of samples being brought to the surface will influence sampling at depth. It is essential that samples are taken from within a natural stratum or fill horizon and not across strata boundaries.

At the surface, samples at (0–100 mm) or (0–150 mm) should be taken unless there is evidence of a thin superficial layer of contamination. Where there is good evidence that contamination is restricted to a thin superficial layer, a shorter sampling interval may be appropriate, however, a subset of deeper samples should be analysed. At greater depths, the sampled interval should be no more than (150 mm) to avoid a compositing effect.

Field Rankings and Headspace Analysis

Boreholes should be geologically logged by a competent professional and field classified based on visual and olfactory examination. The soil description should include soil type, consistency, colour, structure, grain size, shape, sorting, particle type and cementation, moisture and origin.

Any obvious odours should be recorded, however direct smelling of any samples should be avoided.

Where the contaminants of concern are volatile organic compounds (VOCs), headspace screening may be a useful field-screening tool. Headspace screening should be undertaken using a photo-ionization detector (PID) or other appropriate instrument. Where possible, all instruments should be calibrated on-site. Calibration documentation should be incorporated into any reports produced.

The ambient air and soil at background locations adjacent to the site should also be screened. All background concentration results should be fully documented and incorporated into any reports produced.

A number of factors affect the relationship between the overall concentration of a given contaminant in the soil and its concentration in the vapour phase. These include soil porosity, soil water content, organic carbon content, soil temperature and weathering of the contaminant. Hence the composition of volatile substances in the vapour phase may not accurately reflect their occurrence in soils. In addition, instruments used to obtain headspace results are not designed or capable of detecting individual volatile contaminants that may be present at a site. Sample analysis results are therefore required to confirm any field observations and field tests.

Sampling from Stockpiles and Clean Fill

An in situ soil sampling program informed by site history, inspection and contaminant form is the preferred approach for site assessment. On occasions it is necessary to stockpile soils that have not been assessed or only partially assessed in situ, and to devise a stockpile sampling plan.

Excavation of soil may result in mixing of low-level or uncontaminated soil with smaller quantities of contaminated soil, having the effect of diluting higher concentrations. It is preferable for assessors to supervise excavation and, as far as practicable, segregate stockpiles according to soil and contaminant types and to avoid dilution.

The process of excavating material often results in mixing of strata and different fill and soil types. Stockpiling may cause some segregation of grain sizes particularly on the exterior slopes. The age and surface condition of the stockpile should be assessed, particularly if it has been weathered and subjected to leaching.

The composition of the stockpile should be documented by inspection of its external appearance and excavations into the stockpile by shovel (for small stockpiles) or excavator/backhoe bucket where a shovel cannot reach the centre of the stockpile. The volume of material present should be estimated.

Sampling from stockpiled material to be taken to landfill or from stockpiles of “clean” fill to be brought onto a site, should be conducted according to the frequency described in Table 3.

Table 3: Frequency of stockpile sampling

Stockpile volume (m^3)	Number of samples
<75	3
100	4
125	5
150	6
175	7
200	8
>200	1:25

The fill should be assessed against guideline values unless it can be demonstrated that the material is from a clean source (e.g. borrow pit, quarry) via a letter/certificate from the source.

It should be noted that it is not sufficient to determine the extent of adversely affected soils on the basis of site observations and field measurements. Laboratory analysis of soil samples is required for verification.

Sample point distribution

The stockpile should be sectioned into an appropriate distribution of sampling locations based on inspection, site history and other assessment data about the nature of contaminants present. If a section of the stockpile is known to have a higher level of heterogeneity and greater contamination risk and the balance of the stockpile is relatively homogenous with low-level contamination, sampling bias to the more contaminated section may be considered. If this information is not known, a uniform sample point distribution should be used. A plan should be developed of the stockpile sections and the corresponding sample locations that represent each section. This will allow physical separation of portions of the stockpile for further characterisation, if required, after receipt of the analytical results.

Sampling

Collection of samples from the exterior (300 mm) of the stockpile should be avoided due to the higher risk of weathering and grain size grading errors.

Samples for inorganic and non-volatile components should be taken at various depths towards the centre of the stockpile from (300 mm) below the stockpile surface.

Samples for volatile and semi-volatile compounds should be taken without delay from a freshly excavated surface (500 mm) or greater depth below the stockpile surface.

Systematic sampling directly from excavator buckets during the excavation and stockpile formation process or for appraisal of larger stockpiles is an acceptable strategy in site assessment.

3.3.3 Soil assessment

The selection of appropriate site investigation techniques depends on a number of factors including the stage of the investigation (for example, preliminary assessment or detailed delineation, the depth of investigation required, the contaminant type, volatile or non-volatile, bonded or unbounded asbestos-containing-material), the depth and nature of any fill, and whether an undisturbed sample is required.

The most commonly used investigation techniques are test pits, trenching and drilling of shallow wells. Samples from shallow depth are generally obtained from test pits and trenches or from augers. Samples from greater depths may be obtained by a range of drilling methods including direct push, hollow stem augers, split spoon, Shelby tube, mud rotary and sonic drilling. Methods capable of providing continuous or near-continuous soil cores, such as direct push, split spoon and sonic drilling are preferred. Air drilling and solid flight augers provide highly disturbed samples and poor depth control which limits their value for site characterisation purposes.

A number of screening tools are also available that can be used to rapidly and cost-effectively identify and delineate VOC and semi-VOC (SVOC) contamination in both the unsaturated (vadose) and saturated zones. These include soil vapour sampling, and the laser-induced fluorescence (LIF) and membrane interface probe (MIP) tools. LIF and MIP are real-time tools that can provide detailed logs of the sub-surface and can be used in a reactive or adaptive field sampling program, particularly for volatile substances where trial pitting and some coring methods are not as applicable.

Various geophysical techniques can be used for site characterisation purposes including determining depth to bedrock, delineation of groundwater contamination, location of voids, faults or fractures and the presence of buried items such as steel drums and tanks. The information gained can be used for selecting optimal locations for wells and test pits as well as to correlate geology between wells. The techniques available include metal detectors, magnetometers, electromagnetic conductivity surveys, electrical resistivity—or electrical impedance tomography—and ground-penetrating radar.

A detailed description of geophysical techniques is beyond the scope of this guideline, however, further information can be found in:

- ASTM D6432-99 (2005) Standard guide for the surface ground penetrating radar method.
- ASTM D6429-99 (2006) Standard guide for selecting surface geophysical methods.
- ASTM D5753-05 (2010) Standard guide for planning and conducting borehole geophysical logging.
- Clements, et al. 2009, Characterisation of sites impacted by petroleum hydrocarbons: guideline document, CRC CARE Technical Report no. 11, CRC for Contamination Assessment and Remediation of the Environment, Adelaide.
- NJDEP 2005a, Field Sampling Procedures Manual, New Jersey Department of Environmental Protection. (Available online at www.nj.gov/dep/srp/guidance/fspm).

Detailed information on site investigation techniques can be found on the US EPA CLU-IN characterisation and monitoring webpage at www.clu-in.org/characterization.

3.3.3.1 Soil investigation techniques

Test pits and trenches

Test pits and trenches are generally excavated by hand using a shovel to shallow depths or by machine (backhoe or long-arm excavator) to greater depths. Soil samples may be collected from the walls of a test pit when they are shallow and it is safe to do so in accordance with health and safety requirements. Only freshly exposed surfaces are suitable for sampling volatile and semi-volatile contaminants. Tests pits and trenches expose a large surface area for visual assessment of soil profiles and potential contamination and generally allow the investigator to gain a better appreciation of soil features and soil heterogeneity than that obtained with an individual well.

Intact soil coring

In general, undisturbed samples obtained from near-continuous soil cores are preferred to grab samples for inspection and analysis. Intact soil coring is typically conducted by advancing a hollow rod or thin-walled metal tube into the sub-surface by direct push or other method such as sonic drilling. Direct push methods eliminate the need for a drilling fluid and avoid potential interferences from introduced fluids.

Auger and split-spoon samplers fitted with clear acetate sleeve liners may also be used to collect soil samples; however, sample quality is generally not as good as that obtained using direct push or sonic drilling methods.

Once soil cores have been obtained, samples from specific depth intervals can be taken and suitably preserved for laboratory analysis. Where an entire core is to be taken, the soil core tube should be quickly capped, labelled, wrapped and packed (and kept cool using ice bricks or refrigerated to keep the sample in a relatively undisturbed state) and dispatched to the laboratory for analysis.

Cone Penetrometer Testing

Cone penetrometer testing (CPT) is an in situ form of direct push drilling where sensors are mounted in a cone at the tip of the drill rods. As the cone is advanced, the sensors measure the resistance of the soil to the force of the advancing cone and the data is relayed to an on-board computer which interprets the soil stratigraphy and other parameters. A range of additional sensors may be used with CPT for simultaneous measurement of multiple parameters. The range of available sensors includes pressure head transducers (allowing permeability and hydraulic conductivity assessment), conductivity probes (allowing soil types and saturation to be estimated) and nuclear and pH probes.

CPT is a useful tool for providing rapid, continuous profiles of sub-surface stratigraphy and can save considerable time and money, particularly at large sites with complex geology.

Membrane interface probe

The membrane interface probe (MIP) tool consists of a heated probe equipped with a semi-permeable membrane mounted on a direct push or CPT drilling rig. VOCs diffuse across the membrane and enter a carrier gas within the probe. The carrier gas transports the contaminants to a gas chromatograph at the surface which can be equipped with various detectors for measurement of a wide range of VOCs: an electron capture detector (ECD) for chlorinated organics, a photo-ionisation detector (PID) for aromatic hydrocarbons, and a flame ionisation detector (FID) for straight-chained hydrocarbons.

For sites containing light non-aqueous phase liquids (LNAPL), MIP is typically used to locate and delineate dissolved-phase groundwater and soil–vapour plumes, while laser induced fluorescence (LIF) is used to delineate the LNAPL source zone.

The MIP tool is usually equipped with an electrical conductivity sensor to interpret soil lithologies. The combination of sensors enables an increased understanding of contaminant distribution, particularly in heterogeneous lithologies.

One or more background MIP borings up gradient of each assessment area should be advanced in order to determine the background response. The MIP response can be used to determine concentrations of specific contaminants if it is calibrated with soil and groundwater samples from across the investigation area.

The MIP tool is typically used in the context of an adaptive sampling approach using a dynamic sampling plan, that is, the investigation proceeds in a step-wise approach with the location and depth of each subsequent boring being determined in the field based on the results and interpretation of the preceding boreholes using a predetermined decision framework. Quality Assurance/Quality Control (QA/QC) procedures should be developed for MIP surveys.

With multiple MIP locations and appropriate data interpolation and visualisation software, MIP data can enable a 3-D depiction of NAPL source zones in both the unsaturated (vadose) and saturated zones.

Laser-induced fluorescence

The laser-induced fluorescence (LIF) tool consists of an ultraviolet (UV) or visible wavelength laser connected to a sapphire window, mounted on the side of a direct push/CPT probe tip.

The LIF laser transmits light through the sapphire window, which is then absorbed by any PAHs in contact with the window causing the material to fluoresce at a characteristic wavelength. The fluorescence emission is recorded continuously by a detection system as the probe is advanced.

LIF tools are available which, depending on the wavelengths monitored, are capable of differentiating different types of product. UV LIF systems are appropriate for light fuels up to mid-range oils, but often fail to adequately respond to heavy fuel oil, heavy crudes, coal tars and creosotes. Visible wavelength systems detect heavy fuel oil, heavy crudes, coal tars, and creosotes but do not respond to light fuels such as petrol and kerosene. If possible, an appropriate NAPL sample should be tested to ensure the appropriate wavelength LIF is used.

One or more background LIF borings up gradient of each assessment area are recommended in order to determine the background LIF response. If NAPL is present at the site, a LIF borehole should be advanced adjacent to a well where NAPL has been measured to calibrate the LIF response to the specific NAPL contamination present at the site. The LIF data should also be validated with soil and groundwater sampling to determine concentrations of specific contaminants throughout the investigation area.

As for MIP, the LIF is combined with an electrical conductivity sensor to interpret lithology and is used in a similar reactive sampling approach. Similarly, with multiple LIF locations and the use of data interpolation and visualisation software, LIF data can enable a 3-D depiction of NAPL source areas in both the unsaturated (vadose) and saturated zones.

Soil vapour surveys

Soil vapour surveys may be used to screen sites for VOC and SVOC contamination source areas in the vadose zone and to delineate the extent of contamination. Soil vapour sampling, when applied appropriately, can be used as a screening procedure to assist in locating soil sampling and monitoring well locations.

There are two basic types of soil vapour surveys performed as part of site assessments. The first type is an active soil vapour survey where a volume of soil gas is pumped out of the vadose zone into a sample container or directly into an analyser. The second type is the passive soil vapour survey where a sorbent material is buried in the vadose zone so that contaminant vapours can be selectively absorbed over time using the ambient flow of vapours through the subsurface. The latter is particularly applicable to low permeability soils where active methods are less effective.

Ground penetrating radar

Ground penetrating radar is the most commonly used of the geophysical methods and is typically conducted by rolling a radar unit across the site in a grid pattern and recording and processing the data collected to provide a two-dimensional or three–dimensional image of the surveyed area. Metal objects or near–surface features (such as pipes or utilities) can cause noise on the measured signal; if the location of these features is known, their effect can be minimised in the data processing stage. In homogeneous soil profiles, ground penetrating radar surveys may assist in defining the lateral and vertical extent of NAPL plumes in shallow soil or groundwater.

Field description of soils

Accurate documentation and careful consideration of field observations is essential as this can greatly improve understanding of the variability of contaminant distribution across a site.

All wells (including groundwater monitoring wells) and test pits should be logged and the presence of strata, moisture, seeps or water-bearing zones, elevation of the water level/hydraulic head, imported fill and odorous or stained materials carefully noted. These logs are essential for interpretation of chemical data to establish the extent of contamination and to assist in the design of more detailed investigations.

A photographic record that is well labelled for date, location and orientation is a valuable reference tool for documenting procedures and for understanding soil/aquifer heterogeneity and variability in laboratory results. Photographs are recommended to be taken of the strata present in test pits and soil cores and the appearance of split samples, particularly to illustrate visible heterogeneity in the field.

3.3.3.2 Field testing

A variety of field screening techniques may be used to provide immediate (real-time) information about the concentration and distribution of contaminants on contaminated sites. These tests, by their very nature, are less rigorous and reliable than analytical tests conducted in a laboratory, however, they provide cheaper and quicker results to guide the design of further sampling strategies for site assessment.

The most commonly used field tests include:

- Gas detector tubes.
- Colorimetric test kits.
- Headspace testing using PIDs and FIDs.
- Field portable x-ray fluorescence (XRF) spectrum analysers.
- Field gas chromatography.
- Immunoassay test kits.

These techniques can be used to gain a general understanding of the field conditions and the presence of possible contamination and may assist in the selection of samples for laboratory analysis. PID measurements, for example, may be useful as a field guide to indicate areas of volatile compounds. However, their role in providing real-time data needs to be augmented by laboratory chemical analysis.

Their use as the sole source of analytical data in the assessment of potentially contaminated sites is inappropriate as they may give falsely high or low results. For example, naphthalene is commonly reported in petroleum hydrocarbon-impacted soils and will evoke a response from a PID, in contrast to benzo(a)pyrene (a more significant PAH in terms of human health), which will not be detected by a PID. As these measurements do not always correlate well with laboratory results they are generally not suitable for validation sampling.

Prior to use of any field monitoring equipment there should be:

- A determination that they are capable of detecting relevant contaminants.
- Adequate understanding of the methods of use for the particular instrument, its limitations and site conditions that may affect the results.
- Appropriate calibration (and recording of the calibration data) for the substances being measured.
- An appraisal of site conditions that may affect the results, e.g. high soil moisture may result in artificially high PID results for benzene.

Gas detector tubes

Detector tubes have been developed that measure volatile gases including individual compounds, for example, hydrogen sulphide, or groups of compounds, for example, petroleum hydrocarbons. They can provide a direct measure of the analyte in ambient air or an indirect measurement of soil and groundwater contaminant concentration when used in field test kits for measurement of soil vapour and headspace for liquids. The reagents in the tubes may react with compounds of similar chemical properties; consequently, false positives and inaccurate results are possible and should be identified in the planning process.

Colorimetric test kits

Colorimetric tests rely on the chemical reactions of indicator compounds with individual compounds or classes of compounds. Tests are generally performed by mixing reagents in specified amounts with the soil sample to be tested and comparing the resultant colour change with a colour chart or using a field colorimeter to determine concentration.

Colorimetric tests have been developed for a wide range of substances including BTEX, total PAHs, chlorinated hydrocarbons, PCBs and various individual pesticides and classes of pesticide. The detection limits in soil are generally in the low (ppm) range (lower detection limits are achievable in water as no extraction stage is necessary). Although these tests are relatively simple to perform, depending on the kit, they can suffer from interferences from other co-contaminants or naturally occurring materials or organic matter. Their usefulness for specific site-characterisation purposes can be evaluated by comparison of field colorimetric results with laboratory results over a range of analyte concentrations.

Headspace testing using photo-ionisation and flame ionisation detectors

Field headspace testing is a commonly used method for screening soil samples for volatile and semi-volatile organic compounds. The procedure involves partially filling an airtight container with a fresh soil sample and then analysing the headspace vapour using an appropriately calibrated portable instrument, typically a PID or FID.

A FID uses a hydrogen flame to ionise the organic vapours whereas a PID uses an ultraviolet lamp to ionise the vapours. The instrument response is related to the electric current generated by the ionised compounds. FIDs are most sensitive to aliphatic hydrocarbons as these compounds burn more efficiently than aromatic compounds. PID instruments are most sensitive to aromatic hydrocarbons (for example, BTEX compounds) and can measure most VOCs in the range of C6 equivalent carbon atoms (for example, benzene) to C10 (for example, naphthalene). Neither instrument is effective for detecting non-volatile compounds such as highly weathered hydrocarbons. Care should be taken when using PIDs since a positive bias may result from water vapour or moist air and/or dust being drawn into the instrument. FIDs are not sensitive to water vapour.

A standardised field procedure for headspace testing should be followed and the details of the test method documented (size of jar, soil volume, equilibration time and ambient temperature) in the investigation report.

Field portable x-ray fluorescence

X-ray fluorescence (XRF) is a rapid screening tool that can be used to measure metal concentrations in soil. Performance is dependent on the metal, the soil matrix and soil moisture content. Although a range of heavy metals can be simultaneously detected, there are potential interferences that influence the method accuracy and precision. The US EPA has developed a methodology to guide XRF analysis (US EPA SW-846, Method 6200, Field Portable X-Ray Fluorescence Spectrometry for the determination of elemental concentrations in soil and sediment, Revision 0, February 2007).

The advantages of XRF include real-time results, when used in scanning mode on surface soil, or near real-time results when deeper samples are collected and analysed in the field. The usefulness for specific site-characterisation purposes can be evaluated by comparison of results from split samples analysed by field XRF with laboratory results over a range of analyte concentrations.

Field gas chromatography

Field gas chromatography (GC) may be used for the analysis of volatile and semi-volatile compounds in soil, soil vapour and water. The two main components of a GC are a column to separate the individual constituents and a detector (such as a PID or FID) to measure the signal response of the constituents. The analysis is compound-specific and potentially has the greatest accuracy of all the commonly used field analytical techniques.

Immunoassay test kits

Immunoassay test kits, using antibody-antigen reactions, can be used to measure petroleum hydrocarbons in soil and water. For most kits, the intensity of the colour development is inversely proportional to the amount of substance present. The concentration is determined by comparison with a reference standard or with a portable photometer.

3.3.4 Assessment of soil leachability to groundwater

Contaminants in soil can leach to groundwater under certain conditions. For inorganic substances, leachability is particularly affected by soil pH, contaminant solubility and redox (Eh) conditions.

The leachability characteristics of contaminated soil can be used to help assess:

- The impact of soluble soil contaminants on groundwater quality.
- The impact of leaving contaminated soil materials on site.

Soil leaching tests

The leachability characteristics of a contaminant can be used to help predict the likely impact it will have if the soil is left on site, proposed for re-use or intended for disposal.

Contaminants in soil can leach into groundwater under certain conditions, depending on the local chemistry and geology of a site—leachability is particularly affected by soil pH, contaminant solubility and Redox conditions. These parameters are not controlled in leaching tests but should be recorded from field tests, and other laboratory tests, to ensure that leachability test results can be evaluated accordingly.

A variety of leaching tests are available, and it is important to specifically test leachability in soil under conditions approximating those found in the field or the proposed end-use environment.

Leachability testing can be of two types:

- Batch leaching (or static extraction tests) − equilibrium based.
- Dynamic leaching − column and diffusion based tests.

Generally, batch tests have a much shorter duration than dynamic tests though the latter may give a better representation of contaminant leaching. Batch extraction protocols assume that a steady-state condition is achieved by the end of the test.

All methods are designed to simulate leaching conditions in the environment and thus estimate the likely availability of contaminants. The choice of leaching reagent should be based on the environmental conditions to which the soil or wastes are likely to be exposed — ideally using actual surface and groundwater from the relevant site.

The two most relevant leaching tests for Emirate conditions are:

- Australian standard leaching procedure (ASLP) as per Australian standards 4439.1 (AS4439.1-1999), 4439.2 (AS 4439.2-1997) and 4439.3 (AS 4439.3-1997)
- Toxicity characteristic leaching procedure (TCLP) as per US EPA method 1311, (US EPA SW846, Method 1311).

The ASLP allows a wide range of leaching reagents to be used and is generally the most appropriate leach test to cover a wide range of conditions encountered in contaminated site management in Australia and, it would be expected, in the Abu Dhabi Emirate whether soil is to remain on site or be moved.

The exception is where contaminated soil is to be disposed of at a municipal landfill and mixed with municipal solid waste (MSW), in which case TCLP is more appropriate.

The TCLP was designed to simulate conditions in a MSW landfill. It is not suitable for soil that is NOT intended to be mixed with MSW.

Analysis of appropriate background samples should be included for comparative purposes.

3.3.5 Vapour intrusion assessment

Where volatile contaminants are identified to be present (or potentially present) in soil (or groundwater) beneath a site, the potential for vapours to be generated from the contamination source must be considered. A contaminant is defined as volatile where it has a chemical specific vapour pressure of >1 mm Hg at room temperature, and a Henry's Law constant of >1x10-05 atm/m^3/mol.

Where there is potential for vapours to be generated from a contaminant source, and a building is present above the source area, there is potential for vapours to migrate through the foundations of the building and accumulate in indoor air (this process is known as vapour intrusion). Where vapour intrusion may be occurring, the occupants of the building may be exposed to elevated vapour concentrations which may result in adverse health effects.

Vapour intrusion occurs as a result of diffusion of vapours through the subsurface (i.e. flow of vapours from high concentration to low concentration) and/or as a result of pressure driven flow of vapours (a process known as advection, whereby a pressure gradient exists which forces vapours to migrate through the sub-surface). Where a building is present above a contamination source, vapours can accumulate beneath the slab and migrate through cracks and gaps in the foundations of the building.

The two major classes of volatile compounds which commonly pose a vapour intrusion risk are:

- Petroleum hydrocarbons (gasoline, diesel and jet fuel); and
- Chlorinated hydrocarbons (major components of dry cleaning fluids and degreasing solvents).

These two classes of volatile compounds act very differently in the sub-surface. The main difference between these two classes of compounds is that petroleum hydrocarbons degrade readily under aerobic (oxygenated) conditions, while chlorinated solvents degrade under anaerobic conditions but much more slowly than petroleum hydrocarbons. Therefore chlorinated hydrocarbons are much more likely to accumulate beneath building foundations and result in vapour migration into indoor air.

Preliminary Vapour Intrusion Assessment

It is important to include the vapour intrusion exposure pathways in the CSM for a site to determine whether further investigation may be required. The development of a CSM for vapour intrusion pathways requires a good understanding of the following elements:

- The source of volatile contaminants (e.g. leaking underground storage tank, former dry cleaning activities at the site etc.).
- The nature and extent of the volatile contamination source (i.e. how large, width and thickness, is the area of impacted soil, are volatile impacts present in groundwater).
- The geology and hydrogeology of the site (this will enable an understanding of how the vapours from the source may migrate through the sub-surface).
- People who may be exposed to volatile contaminants (referred to as receptors).
- Preferential pathways for vapour migration (e.g. pipes, underground services, or drains which may transport vapours more readily than the soil profile).
- Buildings and structures present above or near the vapour source, or plans for future buildings.

Once all of the above elements have been considered in a CSM, and it has been identified that there is a potential for vapour intrusion to be occurring the following options are available:

- Applying screening distances where sufficient data is available, noting that screening distances can only be applied to petroleum hydrocarbon sources.
- Undertake a soil vapour assessment to measure actual vapour concentrations in the sub-surface. Compare soil vapour concentrations to appropriate screening values to determine the potential for risks associated with vapour intrusion.

3.4 Laboratory Data QA/QC

Quality assurance (QA) is any systematic process of managing to see whether a product or service is meeting specification requirements. While QA is the process of managing for quality, quality control (QC) is used to verify the quality of the output.

For field sampling QA and QC processes are required to help control sampling errors to an acceptable level. The QA/QC procedures should apply to all the stages of the investigation, such as:

- Experience and qualification, accreditation of staff performing the work, and of all sub-contractors (including the machinery operators and testing laboratory).
- Appropriate sampling plan.
- Sample collection methods.
- Cleaning of equipment.
- Calibration and documentation of field testing equipment.
- Accurate site data recording and data collection, including any field indicators or observations or other conditions present at the time of sampling, these may assist in subsequent data interpretation.
- Appropriate sample storage – packaging and temperature control.
- Accurate and signed chain of custody (COC) completed.
- In field sampling to ensure best outcomes and compliance is to minimize bias and maximize precision. So any systematic deviation (error) in data or bias to be avoided by use of blank sampling. Duplicate samples should be taken at randomly selected sites.

3.4.1 Sample QC

These procedures are used to manage sampling errors and must be documented in the sampling and analysis plan. Procedures should include the collection of field QC samples and ensuring the data collection process is optimum. The number of QC samples taken will be dependent on the type of investigation. Precision in site assessments is achieved by taking QC samples and by increasing the number of site samples taken.

Field QC procedures are used to measure the expected variation and uncertainty in the data caused by sampling, handling and laboratory method errors. Table 4 summarizes the recommended number of field QC samples that should be taken in the sample collection phase.

Table 4: Field QC samples procedures

Quality control sample	Recommended number of samples	Use
Duplicate sample	1 for every 20 samples collected (a second sample collected at the sampling location for every 20 samples collected at the site: see section 3.4.8.1)	All sampling
Triplicate (Split) samples	1 for every 20 samples collected (a third sample collected at the same location as the duplicate for every 20 samples collected at the site: see section 3.4.8.2). This sample is sent to a second laboratory for analysis. 1 per analysis matrix per piece of equipment per day (see section 3.4.8.3)	Site validation / possible problem identified DQO or site dependent
Rinsate blank	1 per consignment* of samples for organics or volatiles or 1 per day / type of equipment (see section 3.4.8.4)	
Field blank	1 per consignment of samples for organics or volatiles (see section 3.4.8.5)	Generally used for water sampling only – DQO or site dependent

** A consignment is a group of samples transported to the laboratory at the same time*

3.4.2 Field sampling requirements

Any soil samples collected during a site investigation must be representative of the problem or site. The requirement is that the area under investigation for contamination to be fully characterized. Each location sampled must be noted on scaled site diagram.

An appropriate sampling method adopted that is set intervals or depths or obvious different materials must be taken. The consultant must ensure that:

- Sampling design is adequate for the site and to meet the project objectives.
- Samples are not cross contaminated by ensuring use of correctly cleaned sampling equipment and following set procedures.
- All sample labelling to be clear.
- Sample labelling on a suitable container writing pane were label does no rub off.
- Use of required containers, e.g. glass jars for volatiles.
- Use correct sampling size.
- Transport and storage of samples is per lab requirements (for example kept cool).
- Audit of laboratory errors by using duplicate samples or split samples.

Any poor field practices or sampling plans will produce poor site characterization. Errors associated with poor field sampling will magnify and be more significant than the analytical errors associated with method used. Errors and uncertainty in results from soil sampling include:

- Samples are not collected from the nominated depths or locations.
- Samples are poorly labelled or incorrectly taken.
- Samples are not stored in the correct containers nominated by laboratory.
- Samples are contaminated by using dirty equipment, or by other instruments if field measurements are taken. Cleaning of equipment and decontamination must be undertaken between collection of each sample, otherwise cross-contamination between samples will occur.
- The parameter of interest is volatile, and samples are exposed to air for a prolonged period.
- Samples are exposed to vehicle exhaust fumes, lubricants and other external sources of contaminants.

3.4.3 Field logging

To ensure the maintenance of sample integrity, the following information will be recorded at the time of sampling. To the maximum extent possible, each sample will be carefully examined and physical properties of the sample described. For each soil sample collected, the following information should be recorded by field personnel using the Unified Soil Classification System (USCS):

1. Project title, job number and sampling date;
2. Name of person collecting sample;
3. Location and identification of sampling point;
4. Method of sample collection;
5. Grain size, colour, texture, odour, plasticity and staining will be recorded as per the USCS;
6. Depth at which sample was collected; and
7. Any soil or water pH, EC or PID readings, presence of any odours, foreign material or visual evidence of staining.

3.4.4 Other field factors for consideration

Soil Disposal

Excess and/or contaminated soil from the sampling activities will be added to the stockpile/s located within the property and further remediated/disposed as required during the soil stockpile remediation phase of site works.

Holding Times

All soil samples collected from the site are required to be submitted to the selected laboratories within recommended holding times to ensure analytical results reported are representative of site conditions. Samples will be transported to the laboratories in batches as soon as is practicable after collection to stay within these holding times.

Equipment Calibration

Equipment used will be calibrated prior to the fieldwork activities and supplied with a calibration certificate. The calibration certificate with the following information will be included in an appendix of the remediation and validation report. Each certificate is required to specify the following detail:

1. Date of calibration;
2. Personnel responsible for calibrating the equipment;
3. Calibration standard details including type and concentration; and
4. Readings following calibration.

Equipment Decontamination

All equipment used at the site will be decontaminated prior to the commencement of fieldwork, between each sampling event, between sampling locations and at the completion of fieldwork. This is required to minimise the potential for cross-contamination of samples and the transportation of contamination off-site.

Small equipment will be decontaminated using the following methodology:

1. Scrubbing with a brush using phosphate free detergent and potable water; and
2. Rinsing of equipment with distilled water.

Qualified Personnel

Fieldwork will be conducted by a Suitably Qualified Person. Field personnel employed to undertake soil investigations and remediation will remain consistent throughout each project to ensure all procedures across the site are comparable.

3.4.5 Laboratory selection

Any analytical laboratories employed to conduct analysis are required to adhere to the internationally recognized (ISO/IEC Guide 17025) and endorsed testing methodologies and conduct regular quality control checks on their analyses. For these laboratories, they with each batch of samples provide results of reagent blanks, control testing standards, repeat duplicates and recoveries to enable an assessment of the accuracy and precision of results reported by the selected laboratories.

The laboratory should participate and have available:

- Regular audits of the laboratory, by outside reviewer from nationally recognized authority.
- History and experience of the type of work that is offered at the laboratory.
- Participation by the laboratory in inter-laboratory comparison programs.

Accreditation by an independent third-party auditing body provides formal recognition that the laboratory meets the minimum standards required. To achieve accreditation a laboratory must prove that they have:

1. Suitable technical expertise.
2. Suitable facilities, instrumentation and quality management systems to carry out the testing involved.
3. Documentation of staff training, test methods, quality procedures, equipment calibration and maintenance.
4. Document control, response to laboratory client queries.
5. Corrective and preventive actions, and ongoing auditing are required.
6. Ensure that personnel from both the auditing agency and independent technical assessors carry out the audit of the laboratory leading the accreditation.

Note that laboratory accreditation does not guarantee that all test methods used are accredited. Accreditation for an individual test method involves the laboratory demonstrating to an independent technical assessor that they have a documented test method procedure, have validated the method, have suitable and up to date equipment, and have staff with the knowledge, experience and competence to carry out the test as documented. The laboratory must also be using the test method on a regular basis. So rarely used methods may not be accredited.

A suitably signed and endorse laboratory certificate/s are required to display the relevant proof of competence and accreditation stamp/s. The final report must contain:

1. Copy of COC.
2. Copy of a Sample Receipt Notification SRN or (sample receipt advice).
3. Analysis laboratory certificate.
4. All QA and QC procedures and results.

These requirements confirm the condition of samples upon receipt by the selected laboratories and process of the testing.

3.4.6 Definitions of laboratory QA/QC

USEPA SW-846 methods (1994) and those that are described by Keith, Environmental Sampling and Analysis, A Practical Guide (1991) describe in detail terms used and definitions of terms.

The Practical Quantitation Limit 'PQL', Limit of Reporting 'LOR', and Estimated Quantitation Limit 'EQL' all refer to the concentration above which reported results can be expressed with a minimum 95% confidence level.

For the purposes of any laboratory reporting, all references to PQL's, LOR's, and EQL's shall be referred to as the laboratory reporting limit and be considered to be equivalent. The laboratory reporting limits are generally set at 2-10 times the Standard Deviation (SD) for the Method Detection Limit 'MDL' for specific analytes.

Any laboratory data values measured at or near the LOR may have two inherent limitations. Firstly, "The uncertainty of the measurement value can approach, and even equal, the reported value. Secondly, confirmation of the analytes reported is virtually impossible unless identification uses highly selective methods. These issues are of lesser importance when reliably measurable amounts of analytes are present in the samples. Accordingly, legal and regulatory actions should be limited to data at or above the reliable detection limit.

Accuracy

Accuracy is the nearness of an averaged result to the true value, where all random errors have been statistically removed. Unless the true value is known, accuracy may take on a meaning equivalent to the term bias due to the existence of systematic errors. Accuracy is measured by percent recovery '%R'. Unless otherwise stated, accuracy data for matrix spike and matrix spike duplicates are expected to vary within the range of:

- General analytes: 70-130 %R.

  Accuracy data shall be treated as an estimate or be rejected on the following assessment criteria:

  % Range: - if 10%R < result < 19%R, then treat the result as an estimate value;

  - if < 10% R, then data value should be rejected.

Precision

Precision is the degree to which data generated from replicate or repetitive measurements differ from one another due to random errors. Precision is measured using the standard deviation 'SD' or Relative Percent Difference '%RPD'. Replicate data existing in the %RPD range presented below shall be accepted as quality data, whereas data outside of the acceptance criteria shall require further discussion.

%RPD Range:

- if result > 10 x EQL, the maximum of 50% RPD;
- if result 5-10 x EQL, the maximum of 75% RPD; and
- if result < 5 x EQL, the maximum of 100% RPD.

3.4.7 Sample handling

3.4.7.1 Project planning

All site investigations must be planned for the site. Depending on the problem, the analytical test requirements should be part of the plan and be chosen to meet the project objectives. The laboratory can advise on testing requirements during the planning phase. Factors that need to be considered by the plan are:

- Sample collection containers- cleaned and sourced from laboratory.
- Ensure non-homogeneous samples are recognized and mixed well before subsampling for laboratory.
- Carefully select any samples that require combining – composites.

- Preservation requirements for particular analytes – using correct preserving method.
- Requirements for storage and transport – cool boxes with ice bricks or refrigeration.
- Provision of trip blanks.
- What type of investigation requirements – soil only or soil and water.
- Correct sample labelling.
- Select analysis that is appropriate.
- Analysis method.
- Use appropriate method to achieve detection limits required.
- Laboratory must provide Method Detection limits (MDL's) with method descriptions.
- Specify any sample retention times for sample retention after testing.

3.4.7.2 Forms to accompany samples

The chain of custody (COC) form (see Appendix C) must accompany samples dispatched to the laboratory and/or emailed to the laboratory. COC provides the proof of transfer of samples from site collection to arrival. The chain of custody must contain the following information and most laboratories require the following:

- Client, project number and project manager.
- Time and date the samples are collected / dispatched.
- Signature and name of person transferring the samples if different to project manager.
- Time and date the samples are received at the laboratory.
- Signature and name of person receiving the samples.
- Name and office contact details for report delivery.
- Turnaround times - Urgency of analysis (priority required).
- Consignment or waybill number if courier.

For each sample or batch of samples provide a listing of:

- Unique sample identifier (exactly as on the sample containers dispatched).
- Sample matrix (e.g. water / soil).
- The tests required, with method reference.
- Listing of specific test methods required for each sample.

Additional useful information:

- How the laboratory results are to be reported (e.g. any combination of hard copy, fax, phone, electronic).
- An indication of possible levels of contaminants in the sample, especially if high (this is very useful for the laboratory, because high levels of analytes may contaminate laboratory equipment, cause cross-contamination of other samples, and require re-analysis using smaller sample amounts, or dilutions, which slows turnaround).
- A laboratory quote or reference number is required for pre-arranged work.
- The name, address and contact details of another laboratory if split samples are to be forwarded for analysis and reported/invoiced direct to the person submitting the samples.

3.4.7.3 Receipt at the laboratory

Each consignment of samples will be given a unique identification reference by the laboratory, and each sample in the consignment or batch must also be individually identifiable. This provides a samples tracking through every stage of analysis in the laboratory.

Laboratory procedures upon receipt will require:

1. All samples be unpacked.
2. Samples checked against the chain of custody (COC).
3. The chain of custody should be completed by the laboratory with the date and time of receipt, laboratory number or identifier, the name and signature of the laboratory representative responsible for the samples.

4. Contain any comments if necessary (e.g. names on chain of custody not matching those on the containers, containers missing or broken, sample temperature or temperature of the sample container).
5. The completed chain of custody should be faxed or emailed to the indicated contact person.
6. In addition a Sample Receipt Notification (SRN).
7. SRN to confirm COC details, expected reporting date, general comments, any container / preservation non- compliance.
8. SRN to summarize requested analyses, and project deliverable such as analysis certificate QA/QC documentation, and COC.

3.4.7.4 Sample holding times compliance

All soil samples collected from the site are required to be submitted to the selected laboratories within recommended holding times to ensure analytical results reported are close as possible to representative of site conditions. Samples will be transported to the laboratories in batches as soon as is practicable after collection. Try to avoid arriving at the laboratory just before the weekend to stay within these holding times.

Recommended sample containers and guideline sample holding times before analysis are in Appendix D (Note - Holding times are recommended only, times may vary depending on the particular sample matrix / particulars). Once a sample has been collected, the nature of the analytes present may change as a result of:

- Poor packaging or preservation, delays in dispatch causing.
- Loss by volatilization.
- Degradation by exposure to light.
- Degradation by exposure to oxygen or other chemicals.
- Degradation by any organisms present in sample.

The rate of sample degradation or loss will depend on the analyte, matrix and other factors present (e.g. oxygen, light, soil microbes, moisture, temperature) and the site conditions. Changes can be minimized by collecting samples in suitable containers, using preservatives (as appropriate), keeping samples chilled, cold or frozen and undertaking dispatch / analysis as soon as possible after collection. Sample preservation methods should be documented and or contained in the appropriate laboratory issued containers with or without preservative added.

When setting the DQO, holding times before analysis should be taken into consideration, and should take account of:

- Laboratory turnaround times.
- Any regulatory (legal) requirements.
- Site location and transport times.
- Number of samples and laboratory capacity.
- Sample storage, preservation and transport.
- Soil samples will be placed in sealed laboratory prepared glass jars, placed in an ice cooled container, and transported as soon as practicable to an analytical laboratory under COC documentation for analytical testing.
- Samples to be analysed for volatile constituents should have as little headspace as possible within the jar.
- Where specific preservation measures are required, the appropriate laboratory containers should be used.
- The SRN from the laboratory should be checked for any non-compliance issues when received.

3.4.7.5 Sample retention after analysis

Samples can be retained at the laboratory for a length of time after the tests have been carried out. This provides opportunity, in case further tests are required, or if there are queries regarding the reported results. The time for which samples are held will depend on the analytes required (e.g. samples for metals can be stored almost indefinitely), sample matrix and storage conditions. Any expected special holding time requirements should be discussed with the laboratory in advance.

The nature of the analytes and possible loss/degradation should be taken into consideration when requesting further analyses from retained samples.

3.4.7.6 Hazardous samples

It is standard practice for laboratories to treat all samples as ‘potentially hazardous’. Safety precautions of appropriate protective clothing, such as laboratory coats, gloves and safety glasses, would be part of laboratory accreditation and are essential. Any hazardous potential must be documented in the site assessment, health and safety plan and should identify any chemical, biological or radiation hazards. The laboratory must also be informed of these.

Samples known to be particularly hazardous must be clearly identified on the container and need special packaging and transport to the laboratory with appropriate labelling both inside and out of transport container. Any transportation issues with hazardous materials must be within the laws governing such materials transport and checked with appropriate authority (air, land and sea).

Accredited laboratories would have a procedure in place for identifying, labelling, storing and disposing of hazardous samples and waste but the laboratory must be advised. Any hazardous samples and hazardous waste generated by the laboratory analysis should be stored in a dedicated area and removed by hazardous waste contractors. In some situations this may include returning the samples to the waste generator for disposal/treatment with the other material on site.

3.4.8 Sample requirements

3.4.8.1 Duplicate samples

Duplicate samples are obtained to evaluate the overall precision of the sampling method and/or the analytical method used by the primary laboratory. Duplicate samples will be obtained from the same sampling point as the parent sample involves collecting two separate (replicate) samples from the single sample location, storing in separate containers and submitting them for analysis to the laboratory as two separate samples. Frequency of duplicate collection is **1 per 20** (or part thereof) primary samples collected. Duplicate samples will be sent to the primary laboratory for analytical testing of the same suite of analytes that the corresponding primary samples are analysed. Assessment of the Relative Percent Difference (RPD) between analytical results obtained for each sample pair should be made in the assessment report.

3.4.8.2 Triplicate samples

Triplicate samples of soil will be obtained to evaluate the analytical method used by the primary laboratory. Triplicate samples will be obtained from the same sampling point as the parent and duplicate samples at a frequency of **1 per 20** (or part thereof) primary samples collected. A split sample is prepared by requesting the primary laboratory to prepare a sample by thorough homogenization and sending a portion to a second independent laboratory for analysis. Triplicate samples will be sent to the secondary laboratory for analytical testing of the same suite of analytes that the corresponding primary and duplicate samples are analysed for at the primary laboratory. Split samples are not applicable for volatiles. Assessment of the RPD between analytical results obtained for each sample set will be made in the assessment report.

A typical data quality objective (DQO) would be a sample to be acceptable if the relative percent difference for split samples is less than 30-50%, depending on the analyte.

3.4.8.3 Rinsate blank samples (Equipment)

Rinsate samples will be used to evaluate the effectiveness of decontamination of reusable sampling equipment between collection of samples and in preventing cross-contamination. A rinsate sample is obtained by pouring laboratory prepared distilled water over the decontaminated sampling equipment and collecting the rinse water in an appropriately preserved sample container for analytical testing. One field rinsate sample will be obtained per day of sampling and per piece of sampling equipment. Laboratory supplied distilled water will be used for this purpose.

The rinsate blank is tested for any residual contamination, which assesses the potential for cross-examination between samples as a result of poor decontamination of sampling equipment procedures. Rinsate blanks for some sampling are collected from equipment that comes in direct contact with the samples (e.g. auger head, sample spoons, trowel), and where cross-contamination of samples is likely to affect the validity of the sampling and assessment process. The recommended practice is to collect one rinsate blank per day, per sampling technique/team, dependent on the site investigation DQOs. The sample should be analysed to provide information whether there are indications of cross-contamination or field contamination.

3.4.8.4 Trip blank samples

Trip blanks are sample bottles filled with deionised water, and originate in the laboratory with the sample containers. They are kept with the soil samples, remain unopened in the field, and are returned to the laboratory. The trip blank is used to identify compounds that may have been introduced into the soil samples during transport or storage.

Trip blank samples assist in determining if false positive results are occurring due to cross-contamination of volatile compounds during storage of samples on site and during transportation to the laboratory. Trip blank sample results will be used to determine whether analytical results are representative of site conditions. Note that trip blanks have a specific holding time limit.

One trip blank is typically collected per consignment of samples, depending on the DQOs. A consignment is a sample group (usually 20-30 samples) that is transported to the laboratory at the same time.

3.4.8.5 Field blank samples

A field blank is similar to a trip blank except that the sample container is exposed to the same field conditions as the sample. It is opened in the field for the period of the soil sampling. Its purpose is to assess the potential for field contamination. Analysis of the field blank is used to identify any compounds that may have been introduced to the sample during sample collection (e.g. from air deposition or vapours). Field blank samples are particularly important for sampling in areas where volatiles substances (e.g. BTEX or TCE) or TPH are present.

3.4.8.6 Sampling of volatiles

Soil samples collected for volatile parameters (e.g. solvents, benzene) must be collected and analysed as soon as possible. Collect the samples using the appropriate soil-sampling equipment. If taking samples using other equipment (e.g. backhoe excavator, auger) there is potential for loss of volatiles. The limitations of the field sampling method must be identified in the reporting stage. Table (5) lists recommended equipment for sampling soils for volatiles.

Table 5: Sampling methods for volatiles

Recommended technique
Continuous samplers
Hollow-stem augers
Split-spoon samplers
Ring samplers
Shelby tubes
Zero headspace samplers

In all cases the sample should be taken to minimize loss of any volatile compounds. This involves using:

- A zero headspace sampler, which is sealed and transported to a laboratory, it can be interfaced directly to the analytical instrumentation (this is an expensive technique).
- Solvent extraction sampling with a coring device and transfer to a pre-weighed vial containing extractant (methanol).
- Direct fill of a glass container filled with no headspace.

For practical reasons, direct fill method is most often used, therefore there is no need for pre-weighed vials, or requirement to handle and transport methanol.

Samples must be collected, sealed and placed in a container containing frozen ice containers to keep chilled. Samples should not be frozen as the glass sample jars can crack or break. Where any field screening is required (e.g. head-space testing), a separate sample must be collected. All samples for volatiles should be delivered to the laboratory as soon as practicable after field sampling.

3.4.9 Sample preparation methods

3.4.9.1 All field samples

All soil samples received at a laboratory should be treated as non-homogeneous and should be mixed before a sub-sample is removed for analysis taking care not to cause loss of analytes. Samples for volatile analyses must remain undisturbed. Unrepresentative material such as sticks, leaves and stones are to be removed before submission to the laboratory, if practicable. Often, the particle size of the sample is often reduced to ensure uniformity of the sample, and this may be done by crushing and grinding.

3.4.9.2 Sub-sampling for the laboratory

The sub-sampling procedure must be carried out after the sample has been homogenized by the laboratory, and must be undertaken in an unbiased manner to ensure that the sub-sample is truly representative of the original sample. It is essential that the sub-sampling procedure does not alter the overall nature of the sample, or cause loss of target analytes for any reason. This is recommended to be carried out by the laboratory.

The method of sub-sampling will depend on both the analytes to be determined, and the sample. Methods of sub-sampling include the following:

- Long-pile method – the sample is laid out in a long pile during the unloading process, the pile is separated into two equal piles by using a shovel and placing alternate shovel loads to either side to form two mounds. Then one mound is randomly selected and the process continued to reduce the sample size.
- Cone and quarter method – the sample is piled into a cone shape with a flattened top, and the cone divided into quarters. The opposite quarters are discarded and the remaining quarters mixed together to form a second cone. The process is repeated until the desired sample size is reached.
- Riffle methods – a riffle is a trough divided into a number of compartments, with doors that open on alternate sides. On each pass through the riffle, soil samples are separated and the sample size is halved.

Sub-samples for analysis of volatiles (volatile organic compounds, BTEX and total petroleum hydrocarbons) should be taken using a technique such as coring, which minimizes losses and gives a reasonably representative sub-sample.

3.4.9.3 Composite sampling

Compositing in the laboratory involves mixing together equal quantities of individual samples to make one composite sample for analysis. This is often done to enable more cost-effective investigations to be undertaken. Composite sampling is not recommended for use in Abu Dhabi.

For example, samples for analysis of volatile and semi volatile constituents such as polycyclic aromatic hydrocarbons and total petroleum hydrocarbons must NOT be composited owing to the potential for the loss of volatiles.

3.4.10 Selection of an analytical method

Analytical methods must meet the requirements of the DQOs. Factors to consider when selecting a method include:

- The required detection limits (e.g. screening methods for initial investigations, specific methods to trace levels for final clean-up validation).
- The required turnaround time for results – lower detection limits usually require more work in the laboratory, which takes more time.
- Analysis cost.
- The required technique (e.g. is the extraction method appropriate for comparison with the guidelines).

Decisions taking into account turnaround time, detection limit and cost need to be made. Laboratories can supply list of methods and detection limits to assist in method selection.

3.4.11 Inter-laboratory comparison programs and certified reference materials

Laboratories should have available validated analytical methods measured against appropriate certified reference materials, as required and practical. Certified reference materials are not available for all analytes and are normally used as part of a method validation but not used as part of the routine laboratory QC samples.

Inter-laboratory comparison programs can be used to demonstrate the ability of a laboratory to undertake analyses on specific sample matrices. Performance results in the comparison programs can also be used in method validation. Ongoing participation in program performances should form part of a laboratory QA program.

3.5 Interpretation of Analytical Data

The assessment of site data requires a review of all sources of information, including the conceptual site model and field and analytical results, and consideration of the site's use and intended uses. When interpreting the soil analytical results, the uncertainty in the data and any limitations in the sampling and analytical method must be understood. All analytical data results are to be compared to the Abu Dhabi specifications and guideline values in Appendix A to determine if the site is suitable for the proposed use or if further remediation and/or management is required.

Professional judgement must be exercised if averaged concentrations are being used for comparison against guidelines. Averages must be used in the context of the exposure pathways, and in some instances may not be appropriate because they can 'hide' hot spot information.

The interpretation of numbers close to limits or guideline values can be done using statistical methods, provided the assumptions and limitations of the statistical method are appropriate and a designed statistical investigation sampling pattern has been used. The recommended method is to use the upper confidence limit of the arithmetic mean. When comparing results to a long-term guideline value, the result will be acceptable if the 95% upper confidence limit is at or below the guideline, provided no result is more than twice the guideline value.

Limitations and uncertainties of the data must be identified, and any assumptions made in interpreting the data clearly stated. Uncertainty in the data can be determined from the use of replicate samples, which provide an indication of the precision of sampling and analysis procedure. Replicate samples should be collected from different locations and the mean and standard deviation calculated for the individual replicates. The information on precision can then be used when comparing results to the maximum allowable limit or guideline value.

When reporting statistical summaries of site investigation data, it is advisable to 'over-report' the results by listing the number in the sample, the standard deviation and the 95% confidence error, because this gives subsequent users the flexibility of deriving other confidence intervals (such as the 99% confidence interval). The 95% confidence error should not be confused with a 95th percentile, which is the value that is greater than or equal to 95% of all values in a distribution.

If appropriate, the following statistics should be reported and can be summarised for each soil stratum tested:

- Number of samples.
- Sample mean (arithmetic and geometric).
- Sample standard deviation.
- 95% confidence error, or 95% upper confidence limit.
- Sample range.
- Coefficient of variation.
- Sample median.

Validation information relating to accuracy and precision of the measurements should form part of any significant contaminated site investigation report. Accuracy is usually assessed by one of two methods:

- Sending duplicate samples for analysis in a different laboratory (inter-laboratory comparison), or
- Analysing samples of a certified reference material.

Certified reference materials are homogeneous reference samples that have been previously analysed, and in which the true values of contaminants can be assumed. These are available in a range of sample types, such as soils, plants and foods, but are not available for all analytes. They essentially represent inter-laboratory comparison in a bottle, and are available from a number of international standards agencies, including LGC (UK), the International Atomic Energy Association (IAEA, Vienna) and the National Institute of Standards and Technology (NIST, USA).

Analytical precision refers to the spread of results, and is usually assessed by repeated measurements of the same sample. Precision is described by measures of variability. The most common statistic used to describe precision is the coefficient of variation. The use of replicates in soil sampling can give an indication of the precision in the sampling and analysis process.

An outlier is one observation in a set of data that appears to be excessively high or low with respect to the mean value suggested by the other observations. Outliers may arise from analytical or sampling difficulties, but may also represent actual site contamination (e.g. a hot spot). In other words, an outlier may be spurious or genuine. Each outlier should be evaluated to determine if it is a real result.

The prevalence of spurious analytical outliers gets higher as the relative concentrations being measured decrease. One reason for this is that minor sample contamination effects (via contact with the atmosphere, sampler, sample container, analyst, laboratory reagents and equipment or instrumental technique) make up a greater part of the overall measurement as the concentration being measured decreases. Due to differences in the magnitudes being measured, spurious outliers are more common in trace background analyses than in contaminated site investigation soil analyses.

The decision to identify an excessively high or low result as an outlier and discard it from the data set requires care and justification. Outliers must be looked at critically to ensure data are not mistakenly ‘lost’ from a site investigation. Where spurious outliers are identified, the original number must not be removed from the site investigation report. Instead, suspected outliers in the data set should be clearly identified (e.g. with an asterisk and footnote). Reasons for the identification of the suspect observation should be provided in the text or a footnote.

There is a range of statistical methods for identifying outlying observations, but they all suffer from the problem that in order to definitively identify an outlier, the nature of the underlying population from which the samples were drawn must be known with reasonable certainty. The best way to get a good idea of the nature of the underlying population is to analyse at least 30 samples. In small data sets (less than 30 samples), statistical methods for outlier rejection should be used only as a last recourse. An outlier should only be rejected if a back check reveals an error. Otherwise it is a real result that requires an explanation.

The recommended checks when excluding outliers include the following.

- Check any calculations for errors.
- Check for the presence of a gross error in your methodology (e.g. any recording error, laboratory error, abnormal conditions during sampling, poor sampling technique).
- Determine whether or not the suspect data point is consistent with the precision of the method (if this is known).
- Retest the suspect sample by repeating the analysis, or collect another sample for testing, to enlarge the overall data set. A single spurious result may become less obvious and have less impact on the mean; or, if it is an outlier, it may look worse.
- Check the observation against the reality of the site.

An assessment of the validity of the data should be made and any uncertainty in the accuracy of the data explained. In particular, the data from the field and laboratory QA/QC must be within the acceptable criteria and any variability or exceedance in acceptability criteria explained. Any uncertainty in the accuracy of the data must also be clarified. A checklist for the data is recommended, as follows.

- Are the site history data consistent with the field observations made during the site inspection (e.g. is there evidence of a tank pit, building foundations or ground disturbance in the anticipated locations based on PSA)?
- Is the labelling on the sample jars the same as on the chain of custody sheet and site plan? (An independent person, other than the field sampler, is best to do this check.)
- Are any data missing (e.g. from the chain of custody or from the laboratory)?
- Are the units correct?
- Are the laboratory data consistent with field observations (e.g. are high results consistent with field observations on contamination)?

- Have all the data been correctly transposed from the laboratory/field records to the report tables and site plan/figures, including the correct units for analysis? An independent peer review of the data should be carried out.

Common mistakes and pitfalls to be avoided in data interpretation include:

- Failing to identify information gaps in the data, such as insufficient numbers of sample results at a specific location or depth to enable a full conclusion to be drawn.
- Drawing definite conclusions in the absence of supporting data.
- Considering laboratory numbers in isolation from other supporting evidence (i.e. not considering the conceptual site model or the field notes).
- Assuming that contaminant results below detection limits imply the contaminant does not exist in the soil.
- Assuming natural strata within the site are the same as background soil (which may not be so if the natural strata have been affected by contaminants).
- Using an inappropriately designed site investigation strategy (e.g. using targeted sampling for a site validation, or collecting soil samples from the incorrect depth based on the conceptual site model).
- Collecting an unrepresentative sample (e.g. taking the soil samples using inappropriate methods, such as using air-flush drilling techniques for volatiles).

3.5.1 Interpreting numbers close to or below detection limits

Numbers close to detection limits

The interpretation of numbers close to method detection limits has uncertainty associated with the measurement in the laboratory due to the small signal being generated by the contaminant relative to the noise associated with the analytical equipment. There is also uncertainty due to the potential for sample contamination, which becomes more significant when undertaking trace level analysis.

Numbers below detection limits

Numbers below detection limits (also referred to as censored data) do not imply that the contaminant does not exist in the soil sample, only that the analytical method was not sufficiently sensitive to be able to detect that level of contaminants. The contaminant may be present at a concentration below the reported detection limit, or it may not be present in the sample at all (the concentration in the sample is zero). If numbers below detection limits are required for comparison against guideline values, then if possible the analysis should be undertaken again using a method with a more sensitive detection limit (the detection limit must be below the guideline value). When interpreting numbers below detection limits, the numbers should not be treated as 'missing', and non-detected results must not be omitted from the results.

The numbers below detection limits can be interpreted in a number of ways:

- Treat the observation as zero.
- Use the numerical value of the detection limit.
- Use the numerical value of half the detection limit (this is the recommended method if there is reason to believe the contaminant is present in a sample).

Data below the detection limit can cause problems with statistical analysis, as any of the above ways of data interpretation introduces constant values, and biases the results. Any data set with a significant proportion of results (e.g. over 25%) below the detection limit should not have any form of confidence intervals reported. In other cases, the statistical analysis of the data should be performed twice − once using half the detection limit as the replacement value, and once using zero − to see if the results differ markedly.

Numbers close to limits and guideline values

Numbers close to limits or guideline values should be interpreted with consideration to the following issues:

- The nature of the guideline (e.g. risk-based clean-up level, background or screening level).
- The context of the site.
- Variability in the data (and sampling design).

It is very rare for repeated analysis of the same sample to yield exactly the same result. The variability in results obtained from repeated analysis of the same sample represents the analytical precision. In cases where replicate samples are collected from the same location and repeatedly analysed, this variability represents a combination of 'sampling and analytical' precision.

3.5.2 Variability in the data

When comparing results to the limits and guideline values, there are three possible outcomes in terms of how the results of any one measurement may relate to the guideline:

- Concentrations in the area represented by the samples are clearly below the limit or guideline value.
- Concentrations in the area represented by the samples are indistinguishable from the limit or guideline value, because they are in the window around the guideline represented by ordinary sampling and analytical variability.
- Concentrations in the area represented by the samples are clearly above the limit or guideline value.

The use of judgemental sampling may preclude statistical methods, because the sampling design is biased. When using judgemental sampling, the confidence intervals cannot be reported and professional judgement is required. The use of blanks and replicates is required to assist in interpreting the data. The blank analytical results should be reported, and if any corrections to analytical results are made based on the blank results these must be clearly documented.

3.6 Reporting

All data gathered during the DSA investigations will be included in this factual report. Drill logs from all excavations and wells will be reproduced in an Appendix. Information shown on diagrams will include:

- The geological log.
- The depth at which groundwater was intersected and the height to which it rose.
- Any water quality information.
- Details of odour or stains noted.
- Any down-hole geophysical data gathered.
- Construction details for monitoring wells including depth and size of casing, location of screen, depth of gravel pack and details about any protector casing placed at the ground surface.

A detailed photographic log with explanations of all site activities will also be included in a separate Appendix.

Any report submitted to EAD for review and approval must be signed by a Suitably Qualified Person and counter signed by an Inspection Section Manager. All persons who made a substantial contribution to this stage of the project will be listed (together with their qualifications and the role that they played) in a table at the beginning of the document.

4 Tracking of Contaminated Soil

Tracking of hazardous waste is undertaken through Tadweer (Center of Waste Management – Abu Dhabi (CWM)), the authority responsible for waste management in Abu Dhabi Emirate. It is anticipated that contaminated soil will be handled under the same tracking system which includes signing off by the generator, signing off by the transporter (called Environmental Service Providers licenced by CWM) and signing off by the site operator where the waste is received. Each truck has a Geographic positioning System (GPS) tracking system which enables confirmation of the waste transportation route.

Currently there is one sanitary landfill (i.e. hazardous waste lined cell) at Al Ain as well as the first lined cell for hazardous waste is scheduled to come into operation at Al Dhafra landfill. In addition to these sanitary landfills, there are several other non-lined cells in landfills which might be able to accept contaminated soil with contaminants which do not leach.

Contaminated soil can also be pre-treated prior to disposal. Treatment technologies in the Emirate are licenced by CWM. Generators of contaminated soil are encouraged to pre-treat the waste before considering disposal at landfill. Treated soil might be used for layering and filling purposes at the site rather than disposing into the landfill.

5 Site Remediation

5.1 Remediation of Contaminated Sites

The aim of the remediation process should be to ensure that human health and the environment are protected from site contamination. The remediation process involves four clear stages:

- Identification of the proposed land use for the site.
- Identification of the environmental values relevant for that land use.
- Determination of the remediation endpoint, including any numerical remediation criteria.
- Long-term management and monitoring applicable to the site.

The environmental values, human health and/or agriculture, to be protected at a site need to be determined on the current, proposed and realistic future uses of the site. This information will be provided through development of a conceptual site model. When more than one environmental value has been identified then remediation should be done to ensure that the most sensitive use is protected.

The environmental values of soil for Abu Dhabi Emirate that have been identified by EAD that should be protected are human health and agriculture.

The remediation of contaminated sites includes five distinct stages:

- Development of a site management plan which includes a remediation plan (RP)—planning the active remedial work and how its success will be evaluated (validated);
- Development of a site management plan (SMP)
- Implementation of the SMP and incorporated RP and validation; and
- If necessary, management of residual contamination as set out in the site management plan (SMP)
- Restriction of land uses (if required).

A RP should be prepared when some form of active remediation (clean-up) is required. The RP defines the purpose and specific objectives of the remediation, documents the evaluation of remediation options, and specifies how the remediation will be carried out and how it will be validated. The remediation activities undertaken and the validation of the remediation works should be documented in a site remediation and validation (SRV) report. Remediation should be planned and undertaken by suitably experienced and qualified consultants and/or contractors.

The RP should define the goals of remediation, and provide the plan of how the remediation objectives will be achieved. The RP should consider all appropriate technologies and include a description of the decision-making process that led to the selection of the preferred remediation method, effectively a remediation options assessment. The RP should outline the remediation methods and strategies to be implemented at the site. It should also address environmental aspects, impacts of the remediation process and how these will be managed.

5.2 Remediation Objectives

Defining the remediation objectives is an important first step in developing the RP. Issues that should be taken into consideration include but are not limited to:

- The risks to be mitigated and the desired outcomes;
- The time frame available to carry out the remedial works;
- The sensitivity of the current or proposed land use and the environmental values applicable to the site;
- The views of stakeholders, particularly owners of affected sites; and
- The acceptability of post-remediation institutional controls such as ongoing site management or a restricted land use on the certificate of title.

The remediation objectives should provide a clear indication of what is to be achieved by the remediation process. The remediation objectives need to be clearly stated in the RP. The remediation objectives are to ensure that the site is suitable for the current and proposed land use and that human health and the underlying groundwater are protected.

The following factors should be considered when determining the remediation objectives:

- The threat the contamination poses to human health or the groundwater.
- Any environmental values related to the site.
- Background concentrations.
- Social considerations including community acceptance and intergenerational equity (ensuring that the polluter pays and not future generations).
- Technical aspects (physical ability to remove, treat, contain or manage the chemical substances within a reasonable timeframe).
- Logistical issues (site access, availability of materials and infrastructure, disposal of wastes).
- Financial (cost of remediation including waste treatment).

From a technical perspective, the reliability and the effectiveness of the remediation to be protective of human health and the groundwater (i.e. longevity and appropriate use of treatment and containment systems) must be considered and reviewed by EAD prior to remediation commencement. The remediation technology must be realistic, suitable and practicable, where appropriate. It should also reflect the complexities of the site contamination outlined in the CSM, and address the risk outcomes identified in either the PSA or DSA.

The remediation strategy should enable prioritisation of actions to be undertaken addressing the highest risks to human health and the environment first. The ranking of high, medium and low priority risks can be made on consideration of the following:

- Proposed land use, e.g. residential versus commercial.
- Extent of exceedance of clean-up limits and guideline values (see Appendix A).

5.3 Remediation Endpoint

The development of the remediation endpoint for any site remediation process needs to consider a range of issues including the objectives of the remediation. The objective of the remediation process determines what land use is applicable to the site and identification of the environmental values that need to be protected to realise that land use. For the purpose of this user guide the remediation endpoint for remediation actions in Abu Dhabi is achieving the screening levels set out in Appendix A for the identified land use.

Linked to the achieving the remediation endpoint, is the consideration of background contamination. The ability to restrict the use of the site if the background levels pose a risk to human health and the groundwater is also an important consideration in determining future land use. Background levels include both natural background levels as well as existing widespread contamination from previous activities on the site or from diffuse sources (such as motor vehicle pollution). In some areas elevated levels of metals may already exceed health criteria and may be at levels that may pose a health risk. If the goal of the remediation is to remediate and manage the site so that the environmental values are protected and it poses no risk to human health or agriculture, then this may not be possible in some areas. If background levels of a contaminant are higher than the screening guideline values identified for the site or where remediation to achieve the screening guideline values is not practicable or feasible, then it may be that restricting the use of the site is the only way to ensure that human health and the groundwater are protected. This is discussed further in Section 6.

Feasibility, practicability and costs are all important issues in determining a remediation endpoint. These considerations need to be balanced by the risk posed by the contamination at the site and proposed future land use. For example, if the proposed land use for the site is a child care centre then the cost of the remediation and timeframe for remediation needs to consider the risk to the health of children that may be exposed to the contamination. If the potential risk is high then cost and practicability associated with remediating the site to be suitable for the use may preclude the use of the site for this purpose. Alternative land uses may need to be considered.

5.4 Remediation Timeframes

The proposed remediation timeframes should be reasonable, linked to the remediation goals and objectives, and be based on site-specific conditions with due consideration of actual or potential harm to human health and groundwater. The remediation timeframes must be commensurate with the risk posed by the contamination at the site and should be acceptable to the affected community. The following factors should be taken into consideration when developing the remediation timeframes:

- PSA and DSA conclusions.
- Current and/or future land use(s).
- Potential risks from exposure to groundwater contamination.
- Sustainability.
- Hydrogeological characteristics.
- Type, source(s), and extent of contamination.
- Multiple elements of the environment which are contaminated that also require remediation.
- Design and capabilities of the remediation technology.
- Reliability of exposure controls.
- Availability of treatment and/or disposal options.
- Community preferences (if appropriate).
- Financial resources of the person who has liability of site contamination.

The time taken to undertake remediation should be related to the level of risk identified at the site. There may be a need for higher-risk sites to be remediated using technologies that will bring about rapid remediation outcomes, even though the technology may not be the lowest-cost solution. If an intermediate remediation goal is required, the timeframe to achieve that goal should be reasonable and based on site-specific factors. At sites where it is anticipated that the timeframe for achieving the final remediation goal will be lengthy, establishing timeframes for intermediate remediation goals can provide a meaningful measure of progress.

Remediation goals in the shortest timeframe are preferred. Longer timeframes may be acceptable when there are adequate monitoring and reliable controls to protect human health and agriculture. Where it has been identified that groundwater has been contaminated, longer timeframes should only be considered where the plume has been appropriately contained.

Remediation timeframes must be clearly stated in the RP and should include remediation measures to ensure that contamination does not migrate off-site.

5.5 Remediation Options

The RP should document the process that has been undertaken to select the proposed remediation approach and demonstrate that the relevant issues relating to the site have been taken into consideration. The evaluation of remedial options should include consideration of the preferred waste hierarchy for site clean-up and/or management as which is outlined below:

- **on-site** treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level; and
- **off-site** treatment of excavated soil, so that the contamination is destroyed or the associated risk is reduced to an acceptable level, after which soil is returned to the site; or, if the above options are not practicable:
- consolidation and isolation of the soil on site by containment with a properly designed barrier; and
- removal of contaminated material to an approved site or facility (e.g. landfill), followed, where necessary, by replacement with appropriate clean fill; or
- where the assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate management strategy while leaving the contamination on-site.

When deciding which option to choose, the sustainability (environmental, economic and social) of each option should be considered, in terms of achieving an appropriate balance between the benefits and effects of undertaking the option. In cases where no readily available or economically feasible method is available for remediation, it may be possible to adopt appropriate regulatory controls or develop other forms of remediation.

The evaluation of remedial options should consider the constraints applying to the site itself as well as the environmental setting and surrounding land uses. Issues that should be taken into consideration include but are not limited to:

- Technical constraints (technical ability to remove, destroy or reduce (treat), contain or manage the substance(s) causing contamination and restore the relevant environmental values);
- Logistical constraints (such as site access, availability of materials and infrastructure and waste disposal);
- Site management issues that may arise from the preferred method(s);
- Acceptability of preferred method(s) to stakeholders, particularly owners of affected sites and neighbours; and
- Sustainability, including waste minimisation.

Table (6) summarises some of the approaches that can be used for soil remediation. Further detail can be found in Appendix E.

Table 6: Examples of soil remediation approaches

Treatment	Sub-group	Description	Applicable contaminants (terms defined below the table)	Remediation location* (terms defined below the table)	Remediation duration** (terms defined below the table)
Bioremediation	Composting	Naturally occurring microbes break down the organic compounds to carbon dioxide, water and soil organics in a controlled environment (in-vessel composting).	TPHs, MAHs PAHs	Off site	Medium
	Composting (including biopiles, enhanced bioremediation)	Addition of organic bulking agent to accelerate the degradation of contaminants.	VOCs, halogenated VOCs, SVOCs, TPHs, explosives	In situ, ex situ, off site	Long
	Phytoremediation (e.g. phytoextraction, phytostimulation, phytostabilisation, rhizodegradation)	Utilisation of natural plant processes to enhance degradation and removal of contaminants. Processes vary depending on which remediation technology is used.	VOCs, halogenated VOCs, SVOCs, inorganics, TPHs, heavy metals	In situ, ex situ	Long
Thermal treatment	Direct-fired thermal desorption	Soil is heated to 500 °C in a rotary kiln to evaporate contaminants. Contaminants are destroyed through heating of vapours to > 1100 °C. Scrubbers and filters deal with the destruction by-products (e.g. acids, particulates).	TPHs, PAHs, OCPs, PCBs, dioxins, furans	Mobile, ex situ	Short
	Enhanced thermal conduction process	Hot air is piped through soil to turn contaminants into gases. The gases are then transferred to a pyrolysis unit, where they are transformed into carbon dioxide and water.	PAHs, PCBs, chlorinated organics	Ex situ	Short to medium
	Electro thermal dynamic stripping process	Soil is heated in situ by strategically placed electrodes. This increases the volatility of contaminants, which are destroyed or reused after extraction from the soil using soil vapour extraction or multiphase extraction.	VOCs, SVOCs, PAHs, TPHs,	In situ	Medium
Chemical	Reduction/oxidation or redox	Involves chemical reactions that change contaminants to compounds that are less toxic, more stable, less mobile or inert. Redox reactions are short for	VOCs, halogenated VOCs, halogenated SVOCs, explosive	In situ, ex situ, off site	Medium

		reduction–oxidation reactions and occur when electrons, hydrogen or oxygen are exchanged between one substance and another.	residues, non-metals, PAHs, pesticides, herbicides		
Physical/chemical	Soil washing	Soil washing physically separates contaminants from soil. Chemicals, such as surfactants, complexing agents, alkalis, acids and flocculants, are commonly added during the process to further improve the separation efficiency. This technology does not destroy contaminants. It increases the volume of useable soil by removing the contaminants originally held within it.	TPHs, PAHs, halogenated hydrocarbons, PCBs, heavy metals, pesticides, herbicides	Ex situ, mobile	Short
	Soil immobilisation (also known as stabilisation/solidification/ vitrification)	Contaminant solubility, hazard or mobility is decreased through the use of chemical or physical binders (for example, Portland cement, calcium carbonate, manganese oxides).	Heavy metals, PAHs, other organics	Mostly off site	Short
Physical	Soil vapour extraction (multiphase extraction)	Removal and capture of solid contaminant forms that are easily changed into gases by using forced air currents to move the contaminants out of the soil, so they can then be collected.	VOCs, halogenated hydrocarbons, hydrocarbons	Mostly in situ but also ex situ	Medium to long

TPH – total petroleum hydrocarbons
MAH – Monocyclic aromatic hydrocarbon
PAH – Polycyclic aromatic hydrocarbons
VOC – Volatile organic carbon
SVOC – Semi volatile organic carbon
OCP – Organochlorine pesticides
PCB –Polychlorinated biphenyl

Off site - soil is transported off site
Ex situ - on site but excavated
In situ - on site in ground
Mobile - treatment unit is moved from site to site

Short - hours to days
Medium - weeks to months
Long - over 6 months

Soil stockpiles, if not correctly managed, can represent a considerable source of dust, due to their height, un-compacted nature and (frequently) close proximity to sensitive receptors.

The following issues should be considered when stockpiling soil at a site:

- Stockpiles should have a maximum height of about (3 m), or equal to or lower than the average height of surrounding structures. Stockpile height should reduce as it approaches the site boundary.
- Stockpile heights should be below fence lines when within about (5 m) of the boundary.
- Stockpiles should be covered with an effective dust and/or odour mitigation covering. The contents of the stockpile will dictate the level of cover, i.e. complete enclosure or the formation of a crust layer.
- Stockpiles should have sufficient moisture content before being handled. Water can be applied prior to soil excavation or handling activities, allowing sufficient time for water to infiltrate the soil or stockpile.

Applying water to a stockpile during handling has minimal effect on reducing dust emissions. The efficacy of using water jets or sprays to manage airborne dust, especially when handling stockpiles in open areas and in the vicinity of sensitive receptors needs to be considered.

5.6 Validation

Validation enables clean-up performance, in the context of the remediation objectives and remediation targets, to be evaluated. All clean-up carried out should be validated and documented so that EAD can confirm that remediation has been successfully undertaken at the site.

Clean-up is validated by implementing a soil sampling plan that has been designed to characterise the post-remediation condition of the site and provide results that can be assessed against the remediation objectives and remedial targets, i.e. screening guidelines. The sampling plan should consider the potential for contaminant rebound and other site-specific factors such as seasonal effects.

The approaches outlined in Section 3.3 of this user guide for soil sampling should be used in the validation sampling plan. The remedial activities and the results of validation should be documented in a site remediation and validation (SRV) report.

The remediation and validation reporting stage is the process of demonstrating that contamination has been successfully remediated and the objectives and endpoints of the RP have been achieved. Site validation requires sampling to demonstrate remaining soil/sediment, fill material, in-situ remediated material and/or any groundwater affected by the site contamination no longer poses a risk to human health.

Where remediation and validation work are conducted in stages, the reporting process may require a series of reports to support the staged remediation objectives achieved. The reporting stages may include:

- Groundwater monitoring events.
- Soil vapour monitoring events.
- Revisions to the CSM.
- Revisions of the risk assessment after the staged remediation and validation work.

The scope of remediation and/or validation work should be conducted in accordance with the previously prepared RP.

6 Site Management Plan

A site management plan (SMP) incorporates 3 stages:

- Development of the RP.
- Site environmental management plan.
- Long-term management requirements which may include institutional controls such as a restricted land use certificate.

The SMP is prepared for the full life of the remediation and post remediation management of the site. The development of a long-term management plan (as part of the SMP) may be required where a site requires some form of post remediation monitoring, or management due to the presence of residual contamination. This approach is considered appropriate in the following circumstances, but is not limited to:

- Complete remediation of chemicals in soils affecting an area is not practicable (for example chemical substances below an impermeable structure).
- Chemical substances in soils are being retained under a final cap or fully contained onsite within an engineered containment cell.
- Remediation is likely to cause a greater adverse environmental impact than would occur if the site was left undisturbed.

In these circumstances, clear statements as to the existence of site contamination must be made. If site contamination does not exist, a management or mitigation measure would therefore not be required. Ongoing monitoring may also be required where an element of the environment is contaminated, i.e. to determine the performance or remedial works or support natural attenuation, or where on-site containment is proposed. An SMP may include provisions for:

- Groundwater monitoring and management.
- Soil stockpile management.
- Bioremediation management.
- Soil vapour monitoring and management.
- Construction environmental management.
- Site maintenance and inspection.

Examples of instances when a long-term management plan may be necessary are provided in Table (7). These assume appropriate assessment has been carried out and site management provides effective mitigation of the risks.

Table 7: Examples where a long-term site management plan may or may not be required

SMP necessary	SMP not generally necessary
Contaminated soil is buried beneath a warning barrier and one metre of clean fill at a commercial site. Activities at the site are likely to include the installation and maintenance of underground services. An SMP is necessary to ensure the correct thickness (elevation) of clean fill is maintained over the contaminated material and detail the requirements for protecting workers and preventing the material being brought to the surface during sub-surface activities.	Contaminated soil is contained beneath a warning barrier, two metres of clean fill and a permanent building. The site classification includes a restriction on disturbing soils beneath the clean fill layer. An SMP is not generally necessary as the material is unlikely to be disturbed unless there is a significant change in use of the site. This is likely to involve planning authorities who would be alerted to the presence of contamination by the restrictions on the title of the land.
A site has been remediated by placing contaminated soil into an engineered containment cell. However, if the containment cell were to fail, the material could pose a risk to groundwater and groundwater users. Periodic groundwater monitoring is required to assess performance of the containment cell. An SMP is necessary to formalise the monitoring plan—who is responsible, details of the monitoring to be carried out, who the information is to be provided to, relevant trigger levels and contingency actions if these are breached.	Soil at a residential development site has been remediated by removal and off-site disposal however groundwater is contaminated and not suitable for non-potable uses such as irrigation. Monitoring has demonstrated that substances are naturally attenuating and further monitoring is not considered necessary. The site classification (remediated for restricted use) includes a restriction on the installation of wells and use of groundwater. An SMP is not generally necessary as new owners should be notified by the vendor of the presence of contamination.

6.1 Purpose and Objectives

An SMP defines how the site is to be managed or monitored to ensure the risks from contamination remain at an acceptable level. An SMP may be required for a finite period, and may be attached to a site in perpetuity or until further remedial work is carried out.

Where a SMP is required to be implemented these plans must accurately and clearly describe:

- The nature and location of chemical substances remaining on the site.
- The objectives of the plan.
- How the chemical substances and/or site will be managed (ongoing remediation).
- Who will be responsible for implementation.
- The knowledge and abilities of those parties who are expected to implement the SMP.
- Evidence of the responsible parties' acceptance to implement the plan (where possible).
- Contingency plans if the management and monitoring measures are not successful.
- Timeframe over which actions specified in the plan will take place.
- Timeframes for any reporting.

The length and contents of the management plans will depend on the complexity of the site issues. There must be sufficient detail within the plan for it to be readily understood and implemented.

6.2 Contingency Measures

An SMP should specify the circumstances that would be considered a material change in conditions requiring action, the actions to be taken and the time frame for action to be taken. A material change in conditions may comprise, but is not limited to:

- The minimum thickness/elevation of clean soil to be maintained over a contaminated layer;
- The integrity of sealed surfaces, buildings or fencing;
- Concentrations or extent of contaminants that are monitored;

- A change in land use or certain activities at a site;
- The identification of new contamination that has not been considered in the SMP; and
- The period of time that the SMP remains relevant to the site.

An SMP should provide clear instructions for the actions to be carried out and time frame for action in the event that a trigger level or other management measure is exceeded. Actions may include, but are not limited to:

- Re-instating the cover of clean soil, or repairing sealed surfaces or fencing;
- Increased monitoring or further site characterisation;
- Active clean-up and/or risk assessment;
- Decommissioning groundwater wells, treatment of water at the point of use or provision of an alternative water source;
- Revision of the SMP;
- Re-reporting the site to EAD if new contamination is known or suspected; and
- Community engagement to inform stakeholders and engage them in the process of evaluating further actions such as remediation and revision of the SMP.

6.3 Monitoring

If periodic reporting of results or conditions is required, the SMP should specify the format and frequency of reporting, and who the report(s) will be provided to. If monitoring of the site includes sampling and analysis of environmental media, then a detailed soil sampling plan should be included in the SMP to ensure consistency in sampling and analysis over time. Reports detailing the results of periodic sampling and analysis should meet equivalent requirements to those applicable to a DSA report. The sampling plan should be periodically reviewed and updated to ensure that the monitoring regime is appropriate for the site conditions.

7 Restricted Land Use

If it is not possible or feasible to remediate a site for a proposed land use, e.g. residential use, institutional controls can be put in place to ensure that he site is not used for that purpose. This can include restricting or prohibiting access to, or use of a site so that people are not exposed to unacceptable levels of contamination.

Contaminated sites where the risks to human health and agriculture have been adequately characterised and where current and potential future receptors can be protected through restrictions on use of the site should be classified as contaminated—restricted use or remediated for restricted use.

The classification will specify the restrictions relevant to the site, for example:

- The site is suitable for commercial/industrial land use (excluding sensitive uses such as child care centres, schools and residential); and
- Contaminated soil that is safely contained at a site is not to be disturbed.

Further contamination assessment or remediation will be required when activities are proposed that are not in accordance with the restrictions on use or if there is a change in site use.

A restricted land use certificate is placed on the title of the land and transfers with ownership of the land. The responsibility for use of the land within its approved use sits with the land owner. A register of restricted use sites should be kept within EAD as part of the contaminated sites database.

Periodic monitoring of soil, groundwater and/or air may be required to monitor the effectiveness of the implemented measures to contain contamination on the site, e.g. groundwater monitoring around an engineered containment system or vapour monitoring in connection with a building that has a vapour control system.

Any change in land use to a more sensitive use e.g. commercial to residential, would require further assessment and remediation to ensure that the land is suitable for the proposed use. This must occur before the restrictions on land use are lifted by EAD.

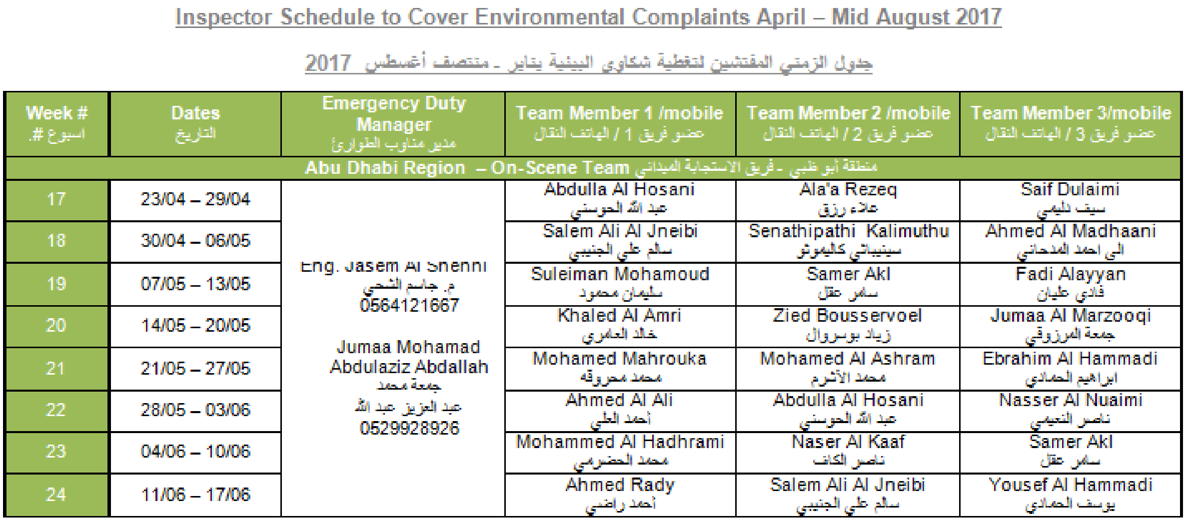
8 Environmental Incident Reporting

An incident is a situation that has the potential to escalate into an emergency should preparatory systems fail to respond adequately. Environmental incident reporting is a method that involves escalating / communicating an environmental incident to the right party in order to speed-up the response process (assessing the situation) depending on the incident, it is assessed on whether the incident is part of EAD's Jurisdiction.

As part of EAD emergency management procedures, the following steps summarize the reporting process:

a. Upon receiving a notification via Abu Dhabi Government Call Centre or partnered stakeholders, thus communicated to the EAD emergency duty manager. Before accepting the case, EAD emergency duty manager must filter and classify the case based on the environmental category whether it is a complaint/Incident/emergency based on the information presented by contacting the notifier directly for confirmation, see Figure (4).

b. All detail must be recorded through the automated investigation tool (OACIS-Environmental Investigation Reporting Module) using the notification form, assigning personnel (based on the duty roster - see Figure 4) to investigate the case then saving the information where a notification reference number will be issued through the site, see Figures (5 & 6). Other response teams are EQS, Terrestrial and Marine Biodiversity Sector (TMBS) depending on the type of case.

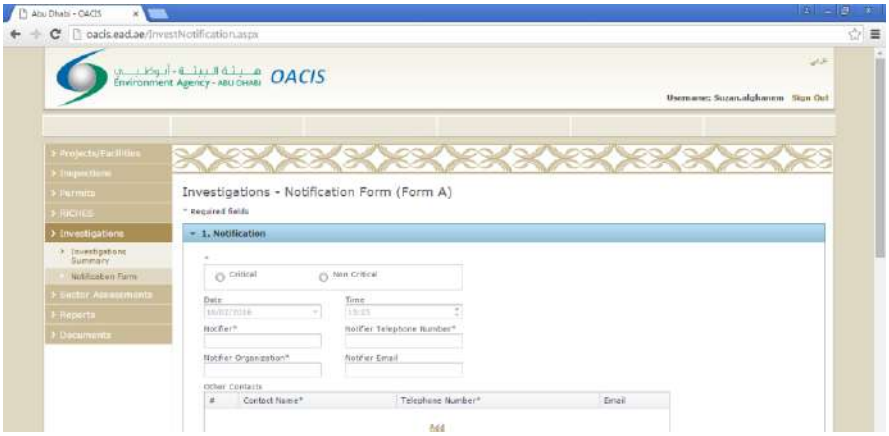


Inspector Schedule to Cover Environmental Complaints April – Mid August 2017

جدول الزمني المقتشين لتغطية شكاوي البيئية يناير ـ منتصف أغسطس 2017

Week # اسبوع #.	Dates التاريخ	Emergency Duty Manager مدير مناوب الطوارئ	Team Member 1 /mobile عضو فريق 1 / الهاتف النقال	Team Member 2 /mobile عضو فريق 2 / الهاتف النقال	Team Member 3/mobile عضو فريق 3 / الهاتف النقال
Abu Dhabi Region – On-Scene Team منطقة أبو ظبي ـ فريق الاستجابة الميداني					
17	23/04 – 29/04	Eng. Jasem Al Shehhi م. جاسم الشحي 0564121667 Jumaa Mohamad Abdulaziz Abdallah جمعة محمد عبد العزيز عبد الله 0529928926	Abdulla Al Hosani عبد الله الحوسني	Ala'a Rezeq علاء رزق	Saif Dulaimi سيف دليمي
18	30/04 – 06/05		Salem Ali Al Jneibi سالم علي الجنيبي	Senathipathi Kalimuthu سينيباتي كاليموثو	Ahmed Al Madhaani الي احمد المدحاني
19	07/05 – 13/05		Suleiman Mohamoud سليمان محمود	Samer Akl سامر عقل	Fadi Alayyan فادي عليان
20	14/05 – 20/05		Khaled Al Amri خالد العامري	Zied Bousservoel زياد بوسروال	Jumaa Al Marzooqi جمعة المرزوقي
21	21/05 – 27/05		Mohamed Mahrouka محمد محروقه	Mohamed Al Ashram محمد الأشرم	Ebrahim Al Hammadi ابراهيم الحمادي
22	28/05 – 03/06		Ahmed Al Ali أحمد العلي	Abdulla Al Hosani عبد الله الحوسني	Nasser Al Nuaimi ناصر النعيمي
23	04/06 – 10/06		Mohammed Al Hadhrami محمد الحضرمي	Naser Al Kaaf ناصر الكاف	Samer Akl سامر عقل
24	11/06 – 17/06		Ahmed Rady أحمد راضي	Salem Ali Al Jneibi سالم علي الجنيبي	Yousef Al Hammadi يوسف الحمادي

Figure 4: Organized duty roster, 2017



Investigations - Notification Form (Form A)

* Required fields

1. Notification

○ Critical ○ Non Critical

Date

Time

Notifier*

Notifier Telephone Number*

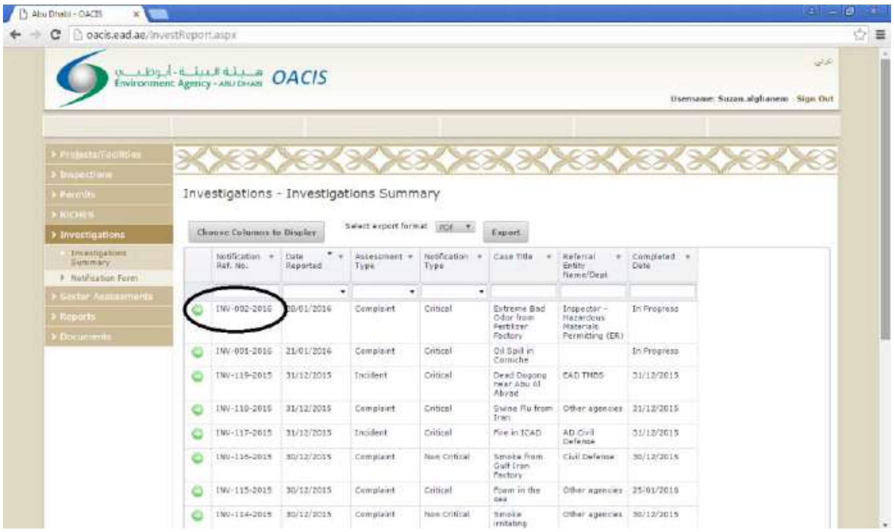
Notifier Organization*

Notifier Email

Other Contacts

#	Contact Name*	Telephone Number*	Email

Figure 5: http://oacis.ead.ae/



Investigations - Investigations Summary

	Notification Ref. No.	Date Reported	Assessment Type	Notification Type	Case Title	Referral Entity Name/Dept	Completed Date
●	INV-002-2016	20/01/2016	Complaint	Critical	Extreme Bad Odor from Fertilizer Factory	Inspector - Hazardous Materials Permitting (ER)	In Progress
●	INV-001-2016	21/01/2016	Complaint	Critical	Oil Spill in Corniche		In Progress
●	INV-119-2015	31/12/2015	Incident	Critical	Dead Dugong near Abu Al Abyad	EAD TMDS	31/12/2015
●	INV-118-2015	31/12/2015	Complaint	Critical	Swine Flu from Iran	Other agencies	31/12/2015
●	INV-117-2015	31/12/2015	Incident	Critical	Fire in ICAD	AD Civil Defense	31/12/2015
●	INV-116-2015	30/12/2015	Complaint	Non Critical	Smoke from Gulf Iron Factory	Civil Defense	30/12/2015
●	INV-115-2015	30/12/2015	Complaint	Critical	Foam in the sea	Other agencies	25/01/2016
●	INV-114-2015	30/12/2015	Complaint	Non Critical	Smoke irritating	Other agencies	30/12/2015

Figure 6: Notification ref. no. after recording the case

c. The assigned personnel downloads the case and investigates using the tough book onsite (see Figure 8), the investigator will assess the environmental situation by giving more updates; once complete the report is later uploaded to http://erts.ead.ae/ as a follow-up for final review by the assigned personnel.

d. During the investigation, the case is declared an emergency by the emergency management team. It is important that once the case is closed, the case must be de-escalated to prevent confusion and media involvement. Below are the following emergency teams that must be involved based on the emergency tier level shown in Figure (7).

Emergency Tier Levels	EAD Emergency Teams involvement
Tier 1	On-Scene Team
Tier 2	On-Scene Team Incident Management Team Crisis Management Team (if required)
Tier 3	On-Scene Team Incident Management Team Crisis Management Team (required)

Awareness training is given to all new employees to familiarize themselves with the EAD Emergency Management Team. Specific trainings are offered based on the mentioned teams on the left.

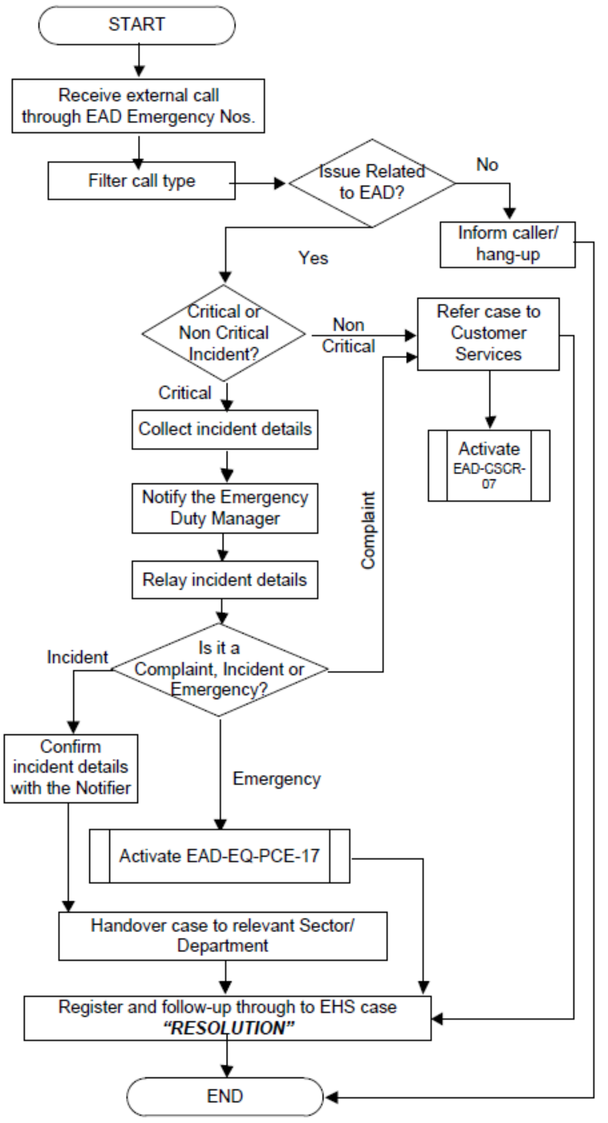
Contact: EOC@ead.ae

Figure 7: Emergency teams by tiers

Figure 8: Example of assigned personnel on-site

	Document Title: **Handling External Incident Notifications Relevant to EAD**			Document Ref No EAD-EQ-PCE-16	
	Prepared by : Emergency Management Team	Approved by : Dr. Humaid Al Kindi	Owned by : Suzan Al Ghanem	Revision Stat 03	Page/Total 1/1

Purpose	**Outline process used by EAD for handling external incident notifications**
Scope	**Initial call filter handling of any external complaint/ incident/ emergency relevant to EAD**



Responsible	**Step**	**Process Flow**	**Details**	
			Input	**Output**
Call Service/ Emergency Duty Manager	1	Receive external call through EAD Emergency Nos.		
Call Service/ Emergency Duty Manager	2	Filter call type Issue Related to EAD?		
Call Service/ Emergency Duty Manager	3	Inform caller/ hang-up	By Telephone / Email	
Emergency Duty Manager	4	Critical or Non Critical Incident? Refer case to Customer Services	Emergency Call Guide EAD-EQ-PCE-16-FM-01	
Call Service/ Emergency Duty Manager	5	Collect incident details	External Incident Notification Section 1: ***"NOTIFICATION"*** of EAD-EQ-PCE-16-FM-02	
Call Service	6	Activate EAD-CSCR-07		
Call Service/ Emergency Duty Manager	7	Notify the Emergency Duty Manager	Call Tree Plan EAD-EQ-PCE-16-FM-03	
Call Service	8	Relay incident details		
Emergency Duty Manager	9	Is it a Complaint, Incident or Emergency?	External Incident Notification Section 2: ***"ASSESSMENT"*** of EAD-EQ-PCE-16-FM-02	
Emergency Duty Manager	10	Confirm incident details with the Notifier		
Emergency Duty Manager	11	Activate EAD-EQ-PCE-17		
Emergency Duty Manager	12	Handover case to relevant Sector/ Department	External Incident Notification Section 3: ***"RESPONSE"*** of EAD-EQ-PCE-16-FM-02	
Emergency Duty Manager	13	Register and follow-up through to EHS case ***"RESOLUTION"***	External Incident Register EAD-EQ-PCE-16-FM-04	External Incident Register "EAD-EQ-PCE-16-FM-04" updated
Emergency Management Team	14	END		

REVISION HISTORY

No	Revision Details	Effectivity Date
00	Initial Issue	15.09.2009
01	Revision 1	11.01.2011
02	Revision 2	08.08.2011
03	Revision 3	02.06.2012
04	Revision 4	01.06.2015

Figure 9: EAD-EQ-PCE-16: Handling external incident notifications relevant to EAD

9 Protection of the Environment during Site Assessment and Remediation

9.1 General Considerations

Assessment of site contamination, or potential contamination, can present risks to the environment as well as to site personnel and local residents. This section provides the minimum measures that should be adopted to ensure protection of the environment during site assessment.

The Abu Dhabi Environment, Health and Safety Management System Regulatory Framework (AD EHSMS RF) requires EAD to have clearly defined and communicated workplace health and safety requirements. Plans developed under such regulatory framework should address all relevant exposure pathways for site-specific contaminants of concern. Site assessment activities should comply with relevant work health and safety guidance and legislation.

9.2 Core Environmental Protection Elements

Environmental protection plans should address the following issues:

- Management of dust emissions and on-site and off-site odours.
- Protection of groundwater resources.
- Prevention of migration of contamination to adjacent sites or uncontaminated areas within the site.
- Prevention of contaminated run-off water reaching storm water systems or wadis.
- Prevention of initiation or spread of fire, either underground or above ground.
- Collection and disposal of excavation spoil.
- Collection and disposal of contaminated groundwater.

Other issues that need to be considered include:

- Spreading contamination or assisting contaminant migration during site investigation works by, for example, drilling through a contaminated aquifer into an uncontaminated lower aquifer thereby creating a conduit through which contamination may migrate.
- Introducing contamination to an otherwise clean soil stratum by backfilling a test pit found to be contaminated at surface level but clean at depth using the contaminated soil. It is always preferable to temporarily stockpile test pit spoil in excavation sequence so that it may be returned to the pit to roughly the same depth from which it was excavated.
- Initiating or extending underground fire by the introduction of oxygen.
- Enhancing acid run-off by enabling oxidation of in situ soils through exposure to atmosphere.
- Destabilising an otherwise stable embankment by site activities.

9.3 Addressing Environmental Protection Issues

The following elements of environmental protection should be considered prior to site assessment and be incorporated into the site assessment plan for each site. In particular, site contamination that is likely to cause public concern by the scale of operations, the nature of the site contamination or the potential for emission of noxious or offensive odours should indicate the commencement of public consultation and community engagement well before the commencement of site assessment works.

9.3.1 Management of dust and offensive and noxious odours

Environmental concerns regularly encountered on site assessments are dust and odour emissions which may be wind-blown and aggravated by the actions of trucks or other plant on the site. When warranted by the scale of site assessment and specific site conditions, area/boundary monitoring for dust deposition, inspirable and respirable dust and respective contaminants should be undertaken. Protection measures are important to ensure that dust inhalation or noxious or offensive odours do not pose a health risk for site operatives, nor a health risk or nuisance to local residents or passers-by and that concentrations of chemical substances do not exceed any relevant Emirate guidelines.

The traditional methods of dust and odour control include:

- Application of a water spray with the objective to dampen the soil and not to saturate it, as this will allow leaching of contaminants down into the underlying groundwater (note: care should be taken when applying water onto soil that has recently been contaminated with volatiles or semi-volatiles, as this can result in a large increase in contaminant emissions from the soil).
- Covering exposed faces with barriers (e.g. synthetic barriers, mulch) to prevent the emission of odours and dust.
- Minimising traffic and its speed on exposed contaminated soils.
- The use of ground covers.
- Installation of screens to act as windbreaks.

Many sites, particularly those with petroleum hydrocarbons, organic contamination or putrescible wastes, may generate offensive odours or noxious vapours. In such cases, intensive odour control measures should be considered including minimising the exposed surface of the odorous materials at all times, timing excavation activities to minimise off-site nuisance, and by re-covering exposed faces overnight or during periods of low excavation activity. Such odorous materials should not be stockpiled unless closely contained or covered.

When dealing with volatile pollutants, an assessment should be made of the need for the regular analysis of atmospheric levels of pollutants on site and at site boundaries to ensure that workers and residents are not being exposed to unacceptable levels of substances (for example, benzene or asbestos) that may give rise to adverse health effects.

In addition, site boundary and competent community monitoring of offensive odours should be regularly undertaken during assessment of problematic sites. Site work practices relating to odour-generating activities should be promptly amended or stopped and reassessed in response to the results of boundary and community monitoring.

The social impact from the excavation of odorous or noxious materials can often be mitigated by excavating only when the wind direction is such that there will be the minimum possible effect upon neighbouring populations.

Where excavation of odorous or noxious material is expected or planned as part of an assessment process, the local population and other stakeholders should:

- Be advised of the expected duration of the operation.
- Be advised that the operation will last for a limited time only.
- Be advised whether or not the odours may pose any potential health risk.
- Be given reassurance with regard to mitigation measures being undertaken.

An effective community engagement program is an essential consideration for sites that pose a risk of offensive or noxious odours.

9.3.2 Protection of groundwater resources

Before commencement of any excavation or drilling work, sufficient research should be undertaken to establish how much information is available regarding the soils, geology and hydrogeology of the area to be investigated. If groundwater contamination is suspected there should be an audit of local wells. If more than one aquifer is expected, care should be taken to ensure that the potential for cross-contamination is minimised. Wells should be constructed so that different aquifers are isolated.

9.3.3 Contaminant movement off site

Care must be taken to avoid surface run-off from assessment activity impacting on adjacent sites or wadis. The site assessor should be aware of the topography, soil type and geology of the site under assessment, and the possibility of migration of contaminants within the site or to adjacent sites, whether wind-blown, adhering to vehicles, plant and equipment, as free-flowing liquids, as surface run-off, or in groundwater flow. Stockpiled, excavated materials awaiting removal from site may create a particular risk to the environment. Mitigation measures may include the use of temporary covers or bonding agents. Temporary bonding around stockpiles, or location of stockpiles on hard surfaces such as asphalt or concrete, or under cover where available, should be considered.

Following wind storms, it may be necessary to retrieve any sediment which has been carried off site and manage this material appropriately. Spraying contaminated groundwater onto stockpiles of contaminated soil as a means of effectively managing the removal of contaminants by wind is also a possibility depending on jurisdictional guidelines and the nature of the contamination.

9.3.4 Contamination carry-over to public roads and highways

Potential carry-over of contamination to public roads and highways is an issue where excavation plant is operating on a site. Care must be taken to ensure that potentially contaminated material is not transported off site. The installation of vehicle ‘rumble strips’ to help dislodge dust and sand from the vehicles, should be considered for installation at exits from sites where potential carry-over is perceived to be a problem.

9.3.5 Collection and disposal of contaminated water

Sample pits should be backfilled soon after sampling. Contaminated water may be encountered where sample pits have been left open, and in wells. Care should be taken in disposing of contaminated flush water from well purging to ensure that contamination is not spread on the site. Gross contamination from well purging should be collected in drums or other suitable container for approved off-site disposal.

After excavation, test pits may fill with groundwater. Care should be taken to ensure that backfilling of the test pit does not rapidly displace this water, causing it to flow over the site. If necessary, the test pit should be part-backfilled and then bailed out to a suitable storage to enable full backfilling with spoil. Contaminated water should be disposed as appropriate.

All containers remaining temporarily on-site, and containing potentially contaminated materials, should be labelled with appropriate warnings and waste producer contact details.

9.3.6 Collection and disposal of excavation spoil

It is normal practice to return excavation spoil from test pits to the excavation from which it came. However, care should be taken to ensure that materials are replaced in soil horizon order and that contaminated materials are not returned to a pit where they could contaminate unaffected strata or groundwater. Due to practical difficulties in compaction of excavation spoil, there may be excess spoil after backfilling of a test pit. Care should be taken to ensure that contaminated spoil does not become spread across an otherwise uncontaminated surface. Drilling cuttings should not be returned to a well.

Excess spoil should be stored in a lined skip or lined drums brought to site or placed on an impermeable surface such as concrete, asphalt, polyethylene sheeting or similar until analytical results can be assessed to enable cost-effective and safe methods of disposal. If contaminated materials are to be drummed for disposal or for treatment, the contents should be analysed, and management decisions made, based on the analytical results. All containers remaining temporarily on-site, and containing potentially contaminated materials, should be labelled with appropriate warnings and waste producer contact details.

Allowances should be made within site assessment budgets for any necessary safe removal of a quantity of soil/fill from the site to an appropriate waste disposal or treatment facility. Transport and disposal of contaminated soil should be carried out in accordance with EAD regulations.

9.3.7 Noise and vibration

Noise can be a health risk to workers and is often a nuisance to those in the vicinity of a site. The potential for noise arising from site assessment activities should be evaluated and appropriate control measures put in place to reduce unacceptable noise (for example, by installing screens or noise baffles). Noise should not be a nuisance to people living or working around the site. Activities with potential for noise generation should be carried out in accordance with relevant EAD regulations.

Similarly, vibration from excavation and drilling, from plant, or from the movement of heavily laden trucks can sometimes result in damage to foundations of adjacent structures or to underground services or utilities. This possibility should be addressed and any risks assessed prior to choice of excavation or drilling method.

9.3.8 Acid sulphate soil

Acid sulphate soils (ASS) are naturally occurring soils, sediments and peats which contain sulphides. In an anoxic (oxygen free) state, these materials are benign and do not pose a significant risk to human health or the environment. However, the disturbance of ASS and exposure to oxygen has the potential to cause significant environmental and economic impacts including contamination of groundwater resources by acid and metals.

Activities that have the potential to disturb ASS, either directly or by affecting the elevation of the water table, need to be managed appropriately.

Where ASS is identified as a potential hazard, investigation and management of ASS should be carried out in accordance with EAD requirements. Prior to any dewatering or excavation activities taking place, the potential impact zone should be identified. If this zone has the potential to impact a marine area, EAD needs to be consulted of the proposed action.

9.3.9 Heritage sites

Special care should be taken to ensure that any assessment works or activities on or adjacent to sites of cultural or natural heritage significance will not have an adverse impact. Heritage places may include buildings, structures, archaeological remains, or landscaped or natural areas of aesthetic, historic, scientific or social value. Where appropriate, advice should be sought from EAD.

9.3.10 Rare habitats, endangered species, forestry areas or wildlife farms

Special care should be taken to ensure that any assessment works or activities will not impact upon rare natural habitats, endangered species, forestry areas or wildlife farms. Advice may be sought from EAD to ensure that site environmental protection plans are sufficiently protective.

10 Auditing

It is recognised that at this stage of the user guide development, that there will be only a limited number of relevant case studies that EAD staff will have been able to participate in. Hence, it is recommended that those staff who participate in these projects are supported through a process which includes internal peer review and auditing by an external experienced contaminated land specialist.

The proposed process would be as follows:

10.1 Internal Peer Review

It is proposed that all reports to be submitted to EAD for review and approval (independent of what stage of the project is being undertaken) will be signed by a suitably qualified person.

These reports will be peer reviewed and then counter signed by an inspection section manager after any recommended changes have been made.

The qualifications of both the suitably qualified person and the inspection section manager are defined elsewhere in the user guide.

10.2 External Auditing

Until sufficient contaminated land assessment and remediation experience has been accumulated within EAD, it is recommended that an external audit program be introduced for assessment reports.

How often should reports be audited? This is a subjective decision but some criteria may be as follows:

- The site selected has a range of complex chemical contaminants present ;
- The site is close to sensitive receptors and may cause community concern;
- Contaminants from the site may have already adversely impacted underlying groundwater which could move off site;
- Contaminated groundwater has already moved off site onto a neighbouring property; and
- Assessment and remediation of a site has to be completed within a short time frame.

Experience has shown that the audit process works most efficiently when the auditor is involved with the project from the early stages.

11 Database and Forms

The regulations supporting the user guide and the associated specifications and guideline values will lead to an increase in the number of sites being assessed for the potential presence of contaminants in the Abu Dhabi Emirate. In order to record the various phases of site notification, assessment and remediation, a comprehensive contaminated sites database will be attached to the soil data base which already exists within EAD. The optimum form of the database will be determined jointly through discussions with the relevant sections within EAD. The database should be operational when the contaminated land regulations come into force in 2018-2019.

An important part of the database is the preparation of appropriate forms (hard copy or digital) to convey the correct information in the best format into the database. The content of the forms is usually structured to ensure that the intent of the regulations is met.

Examples of several contaminated land forms which are used in Queensland are attached in Appendix F and their function is described in Table (8).

Table 8: Examples of contaminated land forms

Form description	Purpose of the form
Duty to Notify	Used to notify the competent authority of events or changes in condition of land causing or threatening to cause environmental harm
Notifiable Activity	Template for landholders or occupiers to give notice to the competent authority that a notifiable (potentially contaminating) activity is being carried out on their land
Contaminated Land Investigation Document	Form used to accompany submission of a contaminated land investigation document to the competent authority
Application for Contaminated Land Soil Disposal Permit	Form for making application to the competent authority for a disposal permit to treat or dispose of contaminated soil

Although the regulations will be different in Abu Dhabi Emirate, it is instructive to review these examples of the format used and the content contained in each of these documents. The final forms to be used in the Emirate will be completed once the regulations have been drafted to ensure consistency with the regulations.

12 Review of the User Guide

The user guide will be reviewed one and three years after issuing the Abu Dhabi specifications for soil contamination, and after the accompanying regulation comes into existence in 2018-2019. Details of the proposed review process are included in a separate Monitoring and Evaluation Plan.

13 References

Abu Dhabi Environmental Specifications for Soil Contamination, Abu Dhabi Quality and Conformity Council, ADS 19/2017

Clements, L, Palaia, T & Davis, J 2009, Characterisation of sites impacted by petroleum hydrocarbons: guideline document, CRC CARE Technical report no. 11, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia

EAD-EQ-PCE-16 Handling External Incident Notifications Relevant to EAD

EAD-EQ-PCE-17 EAD Management of External Emergencies

http://erts.ead.ae/

http://oacis.ead.ae/

OACIS-Environmental Investigation Reporting Module

APPENDICES

APPENDIX A: ABU DHABI SPECIFICATIONS FOR SOIL CONTAMINATION AND GUIDELINE VALUES

Table A. 1: Abu Dhabi Specifications for Soil Contamination

Maximum allowable soil contaminants for residential/open space use

Parameter	Unit	Screening level	Clean-up level
Antimony (Sb)	mg/kg (DW)	31	310
Arsenic (As)	mg/kg (DW)	6.8	68
Beryllium (Be)	mg/kg (DW)	160	1600
Cadmium (Cd)	mg/kg (DW)	71	710
Chromium (Cr VI)	mg/kg (DW)	3	30
Cyanide (CN)	mg/kg (DW)	2.7	27
Cobalt (Co)	mg/kg (DW)	23	230
Copper (Cu)	gm/kg (DW)	3.1	31.0
Lead (Pb)	gm/kg (DW)	4.0	40.0
Manganese (Mn)	gm/kg (DW)	1.8	18.0
Mercury (Hg)	mg/kg (DW)	11	110
Molybdenum (Mo)	mg/kg (DW)	390	3900
Nickel (Ni)	gm/kg (DW)	1.5	15.0
Selenium (Se)	mg/kg (DW)	390	3900
Asbestos	gm/10 kg (DW)	1.0	1.0
Benzene	mg/kg (DW)	12	120
Toluene	gm/kg (DW)	4.9	49
Ethylbenzene	mg/kg (DW)	58	580
Xylene	mg/kg (DW)	580	5800
Polychlorinated Biphenyls	mg/kg (DW)	13.0	130
Benzo(a)pyrene (BaP)	mg/kg (DW)	0.16	1.6
Trichloroethylene (TCE)	mg/kg (DW)	4.1	41
Vinyl Chloride (C2H3Cl)	mg/kg (DW)	0.59	5.9

Note: DW: dry weight

Maximum allowable soil contaminants for industrial/commercial use

Parameter	Unit	Screening level	Clean-up level
Antimony (Sb)	mg/kg (DW)	470	4700
Arsenic (As)	mg/kg (DW)	30	300
Beryllium (Be)	gm/kg (DW)	2.3	23.0
Cadmium (Cd)	mg/kg (DW)	980	9800
Chromium (Cr VI)	mg/kg (DW)	63	630
Cobalt (Co)	mg/kg (DW)	350	3500
Lead (Pb)	gm/kg (DW)	8.0	80
Mercury (Hg)	mg/kg (DW)	46	460
Nickel (Ni)	gm/kg (DW)	22	220
Selenium (Se)	gm/kg (DW)	5.8	58
Asbestos	gm/10 kg (DW)	5.0	5.0
Benzene	mg/kg (DW)	51	510
Toluene	gm/kg (DW)	47	470
Ethylbenzene	mg/kg (DW)	250	2500
Xylene	gm/kg (DW)	2.5	25.0
Benzo (a) pyrene (BaP)	mg/kg (DW)	2.9	29
Polychlorinated Biphenyls	mg/kg (DW)	330	3300

Note: DW: dry weight

Maximum allowable soil contaminants for agricultural use

Parameter	Unit	Screening level	Clean-up level
Antimony (Sb)	mg/kg (DW)	200	2000
Arsenic (As)	mg/kg (DW)	120	1200
Beryllium (Be)	mg/kg (DW)	40	400
Boron (B)	mg/kg (DW)	20	200
Cadmium (Cd)	mg/kg (DW)	14	140
Chromium (Cr VI)	mg/kg (DW)	4	40
Cobalt (Co)	mg/kg (DW)	400	4000
Lead (Pb)	gm/kg (DW)	0.7	7.0
Mercury (Hg)	mg/kg (DW)	66	660
Molybdenum (Mo)	mg/kg (DW)	50	500
Nickel (Ni)	mg/kg (DW)	450	4500
Selenium (Se)	mg/kg (DW)	10	100
Total PAHs	mg/kg (DW)	6	60
Asbestos	gm/10 kg (DW)	1.0	1.0

Note:

1. DW: dry weight
2. This does not include soil quality for growing of crops consumed by human

Table A. 2: General Soil Contamination Screening and Clean Up Level Guidelines

CAS Number	**Chemical Name**	**Residential/ Open Space**		**Commercial/ Industrial**		**Agricultural**		**Notes**
		Screening levels- (mg/kg dry weight)	**Clean Up levels- (mg/kg dry weight)**	**Screening levels- (mg/kg dry weight)**	**Clean Up levels- (mg/kg dry weight)**	**Screening levels- (mg/kg dry weight)**	**Clean Up levels- (mg/kg dry weight)**	
Inorganics (including Metals)								
7440-42-8	Boron	16000	160000	230000	2300000	*	*	
16065-83-1	Chromium (III) insoluble salts	120000	1200000	1800000	18000000	-		
7440-50-8	Copper	*	*	47000	470000	630	6300	
7439-89-6	Iron	55000	550000	820000	8200000	-		
78-00-2	Tetraethyl lead	0.0078	0.078	0.12	1.2	-		
22967-92-6	Methyl Mercury	7.8	78	120	1200	-		
7440-66-6	Zinc	23000	230000	350000	3500000	2000	20000	
57-12-5	Cyanide (free)	*	*	12	120	9	90	
7439-96-5	Manganese	*	*	26000	260000	-		
	Phosphates	3800000	38000000	57000000	570000000	57000000	570000000	See note 3
14797-55-8	Nitrates	130000	1300000	1900000	19000000	1900000	19000000	See note 3
14797-65-0	Nitrite	7800	78000	120000	1200000	-		
7439-98-7	Molybdenum	*	*	5800	58000	*	*	
7446-11-9	Sulfur trioxide	140000	1400000	6000000	60000000	-		
7664-93-9	Sulfuric Acid	1400000	14000000	6000000	60000000			
7647-01-0	Hydrochloric Acid	28000000	280000000	120000000	1200000000			
Asbestos								
	Friable	0.001%w/w		0.001%w/w		0.001%w/w		0.001% is equivalent to 0.1 g asbestos per 10 kg soil
	All asbestos in	**No visible asbestos**						

CAS Number	Chemical Name	Residential/ Open Space		Commercial/ Industrial		Agricultural		Notes
		Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	
	surface soil							
Total Petroleum Hydrocarbons								
	TPH C19-C32 Aliphatic	230000	2300000	3500000	35000000			
	TPH C5-C8 Aliphatic	520	5200	2200	22000			
	TPH C9-C18 Aliphatic	96	960	440	4400			
	TPH C17-C32 Aromatic	2500	25000	33000	330000			
	TPH C6-C8 Aromatic	82	820	420	4200			
	TPH C9-C16 Aromatic	110	1100	60	600			
Polycyclic Aromatic Hydrocarbons								
83-32-9	Acenaphthene	3600	36000	45000	450000			
120-12-7	Anthracene	18000	180000	230000	2300000			
56-55-3	Benzo(a)anthracene	1.6	16	29	290			
205-99-2	Benzo(b)fluoranthene	1.6	16	29	290			
207-08-9	Benzo(k)fluoranthene	16	160	290	2900			
218-01-9	Chrysene	160	1600	2900	29000			
53-70-3	Dibenz(a,h)anthracene	0.16	1.6	2.9	29			
206-44-0	Fluoranthene	2400	24000	30000	300000			
86-73-7	Fluorene	2400	24000	30000	300000			
193-39-5	Indeno(1,2,3-c,d)pyrene	1.6	16	29	290			
91-20-3	Naphthalene	38	380	170	1700			

CAS Number	Chemical Name	Residential/ Open Space		Commercial/ Industrial		Agricultural		Notes
		Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	
129-00-0	Pyrene	1800	18000	23000	230000			
Volatile (and Semi Volatile) Organic Compounds								
71-43-2	Benzene	*	*	*	*	0.3	3	
108-88-3	Toluene	*	*	*	*	3.7	37	
100-41-4	Ethylbenzene	*	*	*	*	0.82	8.2	
1330-20-7	Xylenes (total)	*	*	*	*	110	1100	
56-23-5	Carbon Tetrachloride	6.5	65	29	290	1	10	
127-18-4	Tetrachloroethylene	81	810	390	3900	1	10	
79-01-6	Trichloroethylene	*	*	19	190	0.1	1	
75-01-4	Vinyl Chloride	*	*	17	170	-		
71-55-6	1,1,1-Trichloroethane	8100	81000	36000	360000	1	10	
156-59-2	cis-1,2-Dichloroethylene	160	1600	2300	23000	-		
156-60-5	trans-1,2-Dichloroethylene	1600	16000	23000	230000	-		
1634-04-4	Methyl-tert-Butyl Ether	470	4700	2100	21000	-		
50-00-0	Formaldehyde (CH2O)	170	1700	730	7300			
Polychlorinated Biphenyls								
12674-11-2	~Aroclor 1016	4.10	41	51.00	510			
11104-28-2	~Aroclor 1221	2.00	20	8.30	83			
11141-16-5	~Aroclor 1232	1.70	17	7.20	72			
53469-21-9	~Aroclor 1242	2.30	23	9.50	95			
12672-29-6	~Aroclor 1248	2.30	23	9.50	95			
11097-69-1	~Aroclor 1254	1.20	12	9.70	97			

CAS Number	Chemical Name	Residential/ Open Space		Commercial/ Industrial		Agricultural		Notes
		Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	
11096-82-5	~Aroclor 1260	2.40	24	9.90	99			
11126-42-4	~Aroclor 5460	35.00	350	440.00	4400			
39635-31-9	~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	1.30	13	5.20	52			
52663-72-6	~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	1.20	12	5.20	52			
69782-90-7	~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	1.20	12	5.10	51			
38380-08-4	~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	1.20	12	5.10	51			
32774-16-6	~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	0.00	0.012	0.01	0.05			
65510-44-3	~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	1.20	12	5.00	50			
31508-00-6	~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	1.20	12	5.00	50			
32598-14-4	~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	1.20	12	5.00	50			
74472-37-0	~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	1.20	12	5.10	51			
57465-28-8	~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	0.00	0.0037	0.00	0.015			
32598-13-3	~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	0.38	3.8	1.60	16			

CAS Number	Chemical Name	Residential/ Open Space		Commercial/ Industrial		Agricultural		Notes
		Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	
70362-50-4	~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	0.12	1.2	0.49	4.9			
	Total PCBs	*	*	*	*	5.00	50.00	
Phenols								
108-95-2	Phenol	19000	190000	250000	2500000	1	10	
95-57-8	2-Chlorophenol	390	3900	5800	58000	38	380	
95-48-7	2-Methylphenol (o-cresol)	3200	32000	41000	410000	1	10	
108-39-4	3-Methylphenol (m-cresol)	3200	32000	41000	410000	1	10	
106-44-5	4-Methylphenol (p-cresol)	6300	63000	82000	820000	1	10	
1319-77-3	Cresols	630	6300	82000	820000	1	10	
105-67-9	2,4-Dimethylphenol	1300	13000	16000	160000	1	10	
120-83-2	2,4-Dichlorophenol	190	1900	2500	25000	38	380	
88-06-2	2,4,6-Trichlorophenol	49	490	820	8200	38	380	
87-86-5	Pentachlorophenol	10	100	40	400	38	380	
Herbicides and Pesticides								
72-54-8	DDD	23	230	96	960			
72-55-9	DDE	20	200	93	930			
50-29-3	DDT	29	290	85	850			
309-00-2	Aldrin	0.39	3.9	1.8	18			
60-57-1	Dieldrin	0.34	3.4	1.4	14			
12789-03-6	Chlordane	17	170	75	750			
115-29-7	Endosulfan	470	4700	7000	70000			
72-20-8	Endrin	19	190	250	2500			

CAS Number	Chemical Name	Residential/ Open Space		Commercial/ Industrial		Agricultural		Notes
		Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	
76-44-8	Heptachlor	1.3	13	6.3	63			
1024-57-3	Heptachlor epoxide	0.7	7	3.3	33			
118-74-1	Hexachlorobenzene (HCB)	2.1	21	9.6	96			
72-43-5	Methoxychlor	320	3200	4100	41000			
2385-85-5	Mirex	0.32	3.2	1.7	17			
8001-35-2	Toxaphene	4.9	49	21	210			
319-84-6	alpha-hexachlorobenzene	0.86	8.6	3.6	36			
319-85-7	beta-hexachlorobenzene	3	30	13	130			
58-89-9	gamma-hexachlorobenzene (Lindane)	5.7	57	25	250	0.1	1	See Footnote 4
20859-73-8	Aluminium phosphide	31	310	410	4100	410	4100	See Footnote 3
68359-37-5	Beta- cyfluthrin	1600	16000	21000	210000	21000	210000	See Footnote 3
2921-88-2	Chlorpyrifos	63	630	820	8200	820	8200	See Footnote 3
74115-24-5	Clofentizene	820	8200	11000	110000	11000	110000	See Footnote 3
52315-07-8	Cypermethrin	630	6300	8200	82000	8200	82000	See Footnote 3
66215-27-8	Cyromazine	470	4700	6200	62000	6200	62000	See Footnote 3
35367-38-5	Diflubenzuron	1300	13000	16000	160000	16000	160000	See Footnote 3
39148-24-8	fosetyl- aluminium	190000	1900000	2500000	25000000	2500000	25000000	See Footnote 3
1071-83-6	Glyphosate	6300	63000	82000	820000	82000	820000	See Footnote 3
78587-05-0	Hexythiazox	1600	16000	21000	210000	21000	210000	See Footnote 3

CAS Number	Chemical Name	Residential/ Open Space		Commercial/ Industrial		Agricultural		Notes
		Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	Screening levels- (mg/kg dry weight)	Clean Up levels- (mg/kg dry weight)	
67485-29-4	Hydramethylnon	19	190	250	2500	250	2500	See Footnote 3
36734-19-7	iprodione	2500	25000	33000	330000	33000	330000	See Footnote 3
121-75-5	Malathion	1300	13000	16000	160000	16000	160000	See Footnote 3
21087-64-9	Metribuzin	1600	16000	21000	210000	21000	210000	See Footnote 3
8012-95-1	Mineral oils	230000	2300000	3500000	35000000	3500000	35000000	See Footnote 3
3383-96-8	Temephos	1300	13000	16000	160000	16000	160000	See Footnote 3
23564-05-8	Thiophanate Methyl	5100	51000	66000	660000	66000	660000	See Footnote 3

Note 1: In areas where background arsenic levels exceed the screening criteria land uses should be restricted to protect human health. Exposure to soil should be minimised by providing barrier between the soil and places where people, in particular children, may be exposed.

Note 2: For contaminants that are known human carcinogens the target screening level should be at a level no greater than 1 in a million if the land is proposed for a sensitive use such as a child care centre, school, kindergarten etc where children may come in direct contact with the soil. If this isn't possible then permanent barriers such as paving, concreting, use of artificial turf should be put in place to reduce the exposure of children and reduce the potential cancer risk.

Note 3: With the exception of Lindane the commercial/industrial screening and clean-up levels have been adopted to protect workers from exposure to pesticides/herbicides through soil exposures in an occupational setting. This assumes that the workers use PPE such as gloves when in contact with soil during the work day. The commercial/industrial screening and clean up levels for nitrates and phosphates have also been included as agricultural guidelines to protect workers.

Note 4: The agricultural screening and clean-up levels for Lindane are based on the toxicity to crops and grazing animals which are the most sensitive species for the impact of Lindane.

Note 5: In areas where reclaimed land, such as construction of the islands, is proposed for residential use or open space and the screening levels cannot be achieved risk management practices should be implemented to minimise risk. This would include permanent barriers such as paving, concreting, use of artificial turf which should be put in place to reduce the exposure of people and reduce the potential risk to health.

*: As shown in Table (A. 1).

Table A. 3: Special Consideration Soil Contamination Guidelines for Known Human Carcinogens

Soil-Gas-Screening Numbers for Volatile Chemicals below Buildings Constructed with Engineered Fill below Sub-slab Gravel

Chemical	Soil-Gas-Screening Number (µg per litre of soil gas)	
	Residential Scenario	Commercial/Industrial Scenario
Benzene	8.5 E-02	2.8 E-01
Carbon Tetrachloride	6.3 E-02	2.1 E-01
1,2-Dichloroethane	1.1 E-01	3.6 E-01
cis-1,2-Dichloroethylene	4.1 E+01	1.2 E+02
trans-1,2-Dichloroethylene	8.4 E+01	2.4 E+02
Mercury (elemental)	2.0 E-01	5.6 E-01
Methyl tert-Butyl Ether	8.6 E+00	2.9 E+01
Naphthalene	9.3 E-02	3.1 E-01
Tetrachloroethylene	4.7 E-01	1.6 E+00
Tetraethyl Lead	1.6 E-03	4.5 E-03
Toluene	3.2 E+02	8.9 E+02
1,1,1-Trichloroethane	2.5 E+03	7.0 E+03
Trichloroethylene	1.3 E+00	4.4 E+00
Vinyl Chloride	2.8 E-02	9.5 E-02
m-Xylene	8.5 E+02	2.4 E+03
o-Xylene	7.4 E+02	2.1 E+03
p-Xylene	8.0 E+02	2.2 E+03

Soil-Gas-Screening Numbers for Volatile Chemicals below Buildings Constructed without Engineered Fill below Sub-slab Gravel

Chemical	Soil-Gas-Screening Number (µg per litre of soil gas)	
	Residential Scenario	Commercial/Industrial Scenario
Benzene	3.6 E-02	1.2 E-01
Carbon Tetrachloride	2.5 E-02	8.5 E-02
1,2-Dichloroethane	5.0 E-02	1.7 E-01
cis-1,2-Dichloroethylene	1.6 E+01	4.4 E+01
trans-1,2-Dichloroethylene	3.2 E+01	8.9 E+01
Mercury (elemental)	4.5 E-02	1.3 E-01
Methyl tert-Butyl Ether	4.0 E+00	1.3 E+01
Naphthalene	3.2 E-02	1.1 E-01
Tetrachloroethylene	1.8 E-01	6.0 E-01
Tetraethyl Lead	2.1 E-04	5.8 E-04
Toluene	1.4 E+02	3.8 E+02
1,1,1-Trichloroethane	9.9 E+02	2.8 E+03
Trichloroethylene	5.3 E-01	1.8 E+00
Vinyl Chloride	1.3 E-02	4.5 E-02
m-Xylene	3.2 E+02	8.9 E+02
o-Xylene	3.2 E+02	8.8 E+02
p-Xylene	3.2 E+02	8.9 E+02

APPENDIX B: LIST OF POTENTIALLY CONTAMINATING INDUSTRIES

Potentially contaminating industries, activities and land uses

The list provided is not exhaustive and it may be necessary to consider whether other contaminants could be present as a result of the activities carried out at the site or whether other contaminants could be present at the site.

Industry, activity or land use	Common contaminant types
Abattoirs and animal processing works	Also refer to tannery and associated trades Nutrients (e.g. nitrogen, phosphorus) Biological oxygen demand Total suspended solids Oil and grease Pesticides and metals (by-products of rendering)
Abrasive blasting	Dependent on material being removed Metals(e.g. iron, lead) Tributyltin (boat yards/boat maintenance)
Acid/alkali plant, formulation and bulk storage	Metals (e.g. mercury) Acids (e.g. hydrochloric, nitric, sulfuric sodium) Alkalis (e.g. sodium and calcium hydroxide)
Airports, airstrips, aerospace facilities	Also refer to fire fighting/training (use of foams) Petroleum hydrocarbons Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene and xylene) Metals (e.g. aluminium, chromium, lead, magnesium) Solvents (e.g. trichloroethene) Also refer firefighting/training (use of foams)
Analysts, analytical laboratory sites (e.g. research, commercial, mine site)	Solvents (e.g. trichloroethene) Acids Metals
Asbestos production or disposal	ACM Asbestos fibres
Asphalt or bitumen manufacture or bulk storage	Petroleum hydrocarbons Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene and xylenes) Polycyclic aromatic hydrocarbons (e.g. creosote) Metals (e.g. chromium, lead)
Automotive repair, engine works and spray painting	Solvents (e.g. trichloroethene) Petroleum hydrocarbons Monocyclic aromatic hydrocarbons (e.g. toluene, xylenes, white spirit) Phenol Chloroflurocarbons Metals (e.g. copper, chromium, lead, zinc) Alkalis Acids (e.g. sulfuric, phosphoric)
Battery manufacturing, recycling, disposal	Metals (e.g. antimony, cadmium, cobalt, lead, manganese, nickel, mercury, silver, zinc) Acids (e.g. sulfuric, hydrochloric)
Biosolids application, muck spreading, organic fertiliser application	Nutrients (e.g. nitrogen, phosphorus) Metals (aluminium, arsenic, cadmium, chromium, cobalt, lead, nickel, potassium, zinc) Phenols Pathogens (e.g. E. coli, Enterococci)
Boat building and maintenance	Also refer to Automotive repair Metals (e.g. copper, chromium, lead, mercury, zinc) Antifouling paints (e.g. organotin, tributyltin)
Brake lining manufacturer	Asbestos Copper
Brickworks	Metals (e.g. ammonium, arsenic, cadmium, mercury, lead) Polycyclic aromatic hydrocarbons (e.g. coke, tars)
Cement/concrete/lime manufacturing or batching	Lime, calcium hydroxide, alkalis Hydrocarbons Asbestos

Industry, activity or land use	Common contaminant types
	Metals (e.g. nickel, zinc)
Cemeteries	Nitrates Heavy metals, lead Formaldehyde Biological hazards
Chemical manufacturing, blending, mixing, handling or storage	
Acid/alkali	Metals (e.g. mercury) Acids (sulfuric, hydrochloric, nitric) Sodium and calcium hydroxides
Adhesive/resins	Polyvinyl acetate (e.g. adhesives) Phenol Formaldehyde (e.g. resins) Phthalate esters Polychlorinated biphenyls Solvents (e.g. trichloroethene)
Dyes/inks	Metals (e.g. cadmium, chromium, cobalt, lead, titanium, zinc) Solvents (e.g. trichloroethene) Cresols Chlorinated hydrocarbons (e.g. 1,1,1-trichloroethane, cis1, 2-dichloroethene)
Fertilisers	Metals (e.g. boron, cadmium, cobalt, copper, magnesium, molybdenum, zinc) Calcium phosphate, calcium sulfate, nitrates, ammonium sulfate, carbonates, potassium Pentachlorophenol
Flocculants	Aluminium
Foam (e.g. polyurethane)	Urethane Formaldehyde Styrene
Fungicides	Metals (e.g. chromium, copper chloride/sulfate, zinc) Carbamates Organochlorine pesticides (e.g. Pentachlorophenol) Chlorinated hydrocarbons (e.g. trichloroethene)
Herbicides	Ammonium thiocyanate 2,4,5-T and 2,4-D Dioxins Herbicides (e.g. triazine, atrazine, MCPA, bipyridyls, sulfonyl ureas, chlorophenoxys) Metals (e.g. arsenic, mercury)
Paints	Metals (e.g. arsenic, barium, cadmium, chromium, cobalt, lead, manganese, mercury, selenium, titanium, zinc) Boron Solvents (e.g. toluene oils natural or synthetic) Resins Chlorinated hydrocarbons Polychlorinated biphenyls
Pesticides	Wide range of insecticides, herbicides and fungicides Metals (e.g. arsenic, lead, mercury, tin, chromium) Organochlorine pesticides Organophosphate pesticides Carbamates Solvents (e.g. xlyenes, kerosene) Chlorinated hydrocarbons Polychlorinated biphenyls Synthetic pyrethroids Acid herbicides Chlorinated hydrocarbons (e.g. mirex)
Pharmaceutical	Solvents (e.g. acetone, ethyl acetate, butyl acetate, methanol,ethanol, isopropanol, butanol) Carbamates Metals (e.g. selenium)

Industry, activity or land use	**Common contaminant types**
Photography	Potassium bromide Metals (e.g. chromium, selenium, silver) Thiocyanate Ammonium compounds Sulfur compounds Phosphate Ethanol Formaldehyde
Plastics	Metals (e.g. cadmium) Carbonates Solvents (e.g. trichloroethene) Styrene Sulfates Phthalate esters Chlorinated hydrocarbons (e.g. 1,1,1 - Trichloroethane) Polychlorinated biphenyls Polybrominated diphenyl ethers
Rubber processing	Metals (e.g. lead, zinc) Sulfur compounds Reactive monomers (e.g. isoprene, isobutylene) Acid (e.g. sulfuric, hydrochloric) Monocyclic aromatic hydrocarbons (e.g. xylenes, toluene) Solvents (e.g. trichloroethene) Carbon Black Hexachlorobenzene Chlorinated hydrocarbons (e.g. mirex, cis 1,2-dichloroethene)
Soap/detergents	Potassium compounds Phosphates Alcohols Esters Sodium hydroxide Surfactants Silicate compounds Acids (e.g. sulfuric, stearic) Oils
Solvents	Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene and xylenes) Chlorinated organics (e.g. carbon tetrachloride, trichloroethane)
Chemical treatment/destruction facilities	As per substances being treated Polycyclic biphenyls (PCBs) Dioxins (refer to Schedule B2 of the NEPM for specific guidance on the occurrence of dioxins and guidance on circumstances where analysis is recommended)
Compost manufacturing	Nutrients (e.g. phosphorus, nitrogen) Metals (e.g. aluminium, iron, potassium, zinc)
Defence works and defence establishments	Also refer Fire fighting training (use of foams) Metals (e.g. aluminium, beryllium, copper, lead, mercury, silver) Explosives (e.g. TNT, 2,4, DNT, 2,6 DNT, RDX) Petroleum hydrocarbons Solvents (e.g. trichloroethene)
Drilling	Drilling fluid additives
Drum or tank re-conditioning or recycling facility	Dependent upon contents of drums Solvents (e.g. methylene chloride, ortho-dichlorobenzene) Petroleum hydrocarbons
Dry cleaning establishments	Solvents (e.g. trichloroethylene, ethane, 1,1,1-trichloroethane, carbon tetrachloride, perchlorethylene) Volatile organic compounds (VOCs)
Electrical substations/transformers	Metals (e.g. copper, lead, mercury, tin) Polychlorinated biphenyls Solvents (e.g. trichloroethene)

Industry, activity or land use	Common contaminant types
Electricity generation/power stations	Fly ash (can comprise of sulfates, metals, total dissolved solids, selenium) Petroleum hydrocarbons Polycyclic aromatic hydrocarbons (e.g. tars, benzo(a)pyrene) Asbestos Polychlorinated biphenyls (PCBs) Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene & xylenes) Metals (e.g. copper, lead)
Explosives production/bulk storage pyrotechnics	Acids (e.g. acetone, nitric, ammonium nitrate, sulfuric) Solvents (e.g. methanol, PCP) Chlorinated hydrocarbons Metals (e.g. aluminium, copper, lead, manganese, mercury, silver) Explosives (e.g. TNT, 2,4 DNT, 2,6 DNT, RDX) Petroleum hydrocarbons (fuel) Hexachlorobenzene
Fertiliser manufacture or storage	Also refer Chemical manufacturing - fertiliser Calcium phosphate, calcium sulfate, copper chloride Sulfur, sulfuric acid Metals (e.g. boron, cadmium, cobalt, copper, magnesium, molybdenum, potassium, selenium) Nitrates
Fibreglass reinforced plastic manufacturing	Solvents (e.g. trichloroethene) Resins Styrene Boron
Fill material/ fill importation	Establish historical potentially contaminating landuse, industry or activity of source site and consider naturally occurring contaminants, e.g. asbestos
Fire fighting and training (use of foams)	Solvents (e.g. glycol ethers) Surfactants (hydrocarbon and fluorinated) Fluorotelomers Perfluorochemicals (e.g. PFOS, PFOA) Boron
Foundry operations	Metals and chlorides/fluorides/sulfates of metals (e.g. iron, aluminium, cadmium, chromium and oxides, copper, lead, magnesium, tin, nickel, zinc) Acids (e.g. sulfuric and phosphoric) Polycyclic aromatic hydrocarbons (e.g. coke residues) Petroleum hydrocarbons (e.g. fuel oil)
Furniture restoration	Solvents (e.g. trichloroethene)
Gasworks	Cyanide Nitrate Sulfide/sulfate Metals (e.g. aluminium, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, zinc) Boron Thiocyanates Petroleum hydrocarbons Polycyclic aromatic hydrocarbons (e.g. creosote) Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene & xylenes) Phenols
Glass manufacturing	Metals (e.g. cobalt)
Iron and steel works	Also refer Gasworks Metals (e.g. chromium VI, cobalt, copper, lead, magnesium, manganese, nickel, selenium, zinc) Acids (e.g. sulfuric, hydrochloric) Mineral oils Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene, and xylenes) Polycyclic aromatic hydrocarbons (e.g. coke residues)

Industry, activity or land use	Common contaminant types
Intensive agriculture (including feedlots and saleyards)	Carbamates Organochlorine pesticides (e.g. Endrin, Methoxychlor, Pentachlorophenol) Organophosphate pesticides Herbicides (e.g. Triazine, Atrazine, 2,4,5-T 2,4-D, MCPA, Picloram) Insecticides DDT, DDE and DDD, Bifenthrin Aldrin and Dieldrin Nitrates Salinity Metals (e.g. aluminium, arsenic, cadmium, copper, iron, lead, magnesium, potassium) Nutrients (e.g. nitrogen, phosphorus) Toxaphene
Landfill sites (and associated activities)	Dependent on landfill type and waste disposed Polychlorinated biphenyls Alkanes Sulfides Metals Asbestos Organic acids Nutrients (e.g. nitrogen, phosphorus) Petroleum hydrocarbons Polycyclic aromatic hydrocarbons (e.g. benzo(a)pyrene) Landfill gases (e.g. methane) Total Dissolved Solids (TDS) Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene & xylenes) Phenols
Livestock dips or spray races	Metals (e.g. arsenic) Carbamates Organochlorine pesticides Organophosphate pesticides Herbicides Synthetic pyrethroids
Market garden, orchards, poly-tunnels, plant nurseries	Metals (e.g. aluminium, arsenic, cadmium, copper, lead, mercury, magnesium, iron) Organochlorine pesticides (e.g. DDT, Dieldrin, Endosulfan) Organophosphate pesticides (e.g. Azinphos ethyl, Diazinon, Fenthion) Carbamates Petroleum hydrocarbon (fuel) Monocyclic aromatic hydrocarbons (e.g. Benzene, toluene, ethylbenzene & xylenes)
Metal finishing and treatments (e.g. electroplating/carburizing baths)	Metals (e.g. aluminium, barium, cadmium, chromium, copper, lead, nickel, tin, zinc) Acids (e.g. sulfuric, hydrochloric, nitric, phosphoric) Paint residues Alkalis Solvents (e.g. 1,1,1-trichloroethane, tetrachloroethylene) Plating salts Monocyclic aromatic hydrocarbons (e.g. Benzene, toluene) Cyanide
Metal smelting or refining	Metals (e.g. aluminium, copper, gold, lead, mercury, selenium, silver, tin) and their chlorides, fluorides and oxides
Mineral processing and extractive industries, including mining, screening, crushing and tailing dams or storage facilities, but not voids where no other potentially contaminating activity has occurred	Acids, alkalis Total Dissolved Solids (TDS) Organic flocculants (e.g. sulfate, cyanide) Metals (e.g. aluminium, arsenic, chromium, cobalt, copper, iron, lead, manganese, mercury, zinc) Petroleum hydrocarbon Monocyclic aromatic hydrocarbons (e.g. Benzene, toluene, ethylbenzene & xylenes) Radioactive materials

Industry, activity or land use	Common contaminant types
	Polycyclic aromatic hydrocarbons asbestos pesticides Solvents (e.g. trichloroethene) Caustic
Motor vehicle manufacture, workshops, facilities, race venues	Petroleum hydrocarbons Monocyclic aromatic hydrocarbons (e.g. Benzene, toluene, ethylbenzene & xylenes) Solvents (e.g. trichloroethene) Resins Heavy metals Polycyclic aromatic hydrocarbons
Oil/gas exploration, production, refining and storage	Petroleum hydrocarbon Monocyclic aromatic hydrocarbons (e.g. Benzene, toluene, ethylbenzene & xylenes) Acids (e.g. sulfuric) Alkalis Insulation lagging (e.g. asbestos) Metals should be determined through assessment of deposit composition and known impurities (e.g. arsenic, barium, cadmium, chromium, cobalt, copper, mercury, nickel) Methyl tertiary-butyl ether Cyanides Drilling fluid additives
Pest control depots	Carbamates Organochlorine and organophosphate pesticides (e.g. Diazinon) Herbicides (e.g. Atrazine) Insecticides (e.g. Fenamiphos) Fungicides
Printing shops	Also refer to Photography Acids Alkalis Solvents (e.g. trichloroethene) Metals (e.g. chromium)
Port/wharf/dock activities (including dredge spoil)	Metals (e.g. copper, tin, chromium, lead, mercury, zinc) Antifouling paints (e.g. organotin, tributyltin) Petroleum hydrocarbons Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene & xylenes) Polycyclic aromatic hydrocarbons
Railway yards/marshalling yards and transport corridors	Petroleum hydrocarbons Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene & xylenes) Phenolics (creosote) Metals (e.g. arsenic, cadmium, chromium, iron, lead, zinc) Nutrients (e.g. nitrates) Carbamates Organochlorine pesticides (e.g. pentachlorophenol) Organophosphates pesticides Herbicides Asbestos Additional contaminants according to what has been transported by rail
Recycling (building materials)	Asbestos Metals (e.g. lead, zinc)
Scrap metal recovery	Metals (e.g. cadmium, lead, magnesium) Solvents Polychlorinated biphenyls Oil and grease Petroleum hydrocarbons Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene & xylenes)

Industry, activity or land use	Common contaminant types
	Polycyclic aromatic hydrocarbons
Service stations and fuel storage facilities	Petroleum hydrocarbons Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene & xylenes) Polycyclic aromatic hydrocarbons Methyl tertiary-butyl ether and other oxygenates Metals (e.g. barium, cadmium, copper, lead, nickel, zinc) Oil and grease Solvents (e.g. trichloroethylene)
Sewage/wastewater treatment plant	Nutrients (e.g. nitrogen, phosphorus) Metals (aluminium, arsenic, cadmium, chromium, cobalt, lead, manganese, nickel, potassium, zinc) Phenols Pathogens (e.g. E. coli, Enterococci)
Tannery (and associated trades)	Acids (e.g. hydrochloric) Metals (e.g. aluminium, chromium, copper, manganese) Formaldehyde Phenols Salts Solvents (e.g. trichloroethene) Petroleum hydrocarbons Oil and grease Cyanide
Textile operations	Metals (e.g. aluminium, cadmium, chromium, titanium, tin, zinc) Carbon Acid (e.g. sulfuric) Alkalis (e.g. caustic soda) Salts Solvents (e.g. perchloroethylene) Monocyclic aromatic hydrocarbons (e.g. benzene, toluene, ethylbenzene & xylenes) Organochlorine pesticides (e.g. Dieldrin, Aldrin) Dyestuff residues Sodium hypochlorite Phenols
Timber preserving/storage/saw mills wood product manufacturing	Solvents (e.g. trichloroethene) Polycyclic aromatic hydrocarbons (e.g. creosote, naphthalene) Organochlorine pesticides (e.g. chlordane, endosulfan, pentachlorophenol) Aldrin and dieldrin Metals (e.g. arsenic, copper, chromium VI, zinc) Boron Cresols

APPENDIX C: EXAMPLE OF CHAIN OF CUSTODY FORM

CHAIN OF CUSTODY - Soil and Water Samples

CLIENT:
OFFICE:
TURNAROUND REQUIREMENTS :
(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)
☐ Standard TAT **(List due date):**
☐ Non Standard or urgent TAT **(List due date):**
PROJECT:
LABORATORY QUC
ORDER NUMBER:
PROJECT MANAGER:
CONTACT PH:

COC SEQUENCE NUMBER (Circle)
COC: **1** **2** **3** **4** **5** **6** **7**
OF: **1** **2** **3** **4** **5** **6** **7**

SAMPLER:
SAMPLER MOBILE:
COC Transmission to:
REPORT FORMAT (or default):
Email Reports to:

RELINQUISHED BY:	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
DATE/TIME:	DATE/TIME:	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY USE	**SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)**			**CONTAINER INFORMATION**		**ANALYSIS REQUIRED including SUITES** (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								**Additional Information**
LAB ID	**SAMPLE ID**	**DATE / TIME**	**MATRIX**	**TYPE & PRESERVATIVE** *(refer to codes below)*	**TOTAL CONTAINERS**									Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
TOTAL														

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Gla
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

APPENDIX D: RECOMMENDED SAMPLE CONTAINERS AND SAMPLE HOLDING TIMES

Solid Samples

Parameter		Container	Preservation	Holding Time (Suggested)
Inorganics and Other Physical Parameters				
Asbestos		PB	Not Specified	Not Specified
Bromide (water soluble)		P, G	Cool to 4ºC	Extraction 7 days, Analyse within 28 days
Chloride (water soluble)		P, G	Cool to 4ºC	Extraction 7 days, Analyse within 28 days
Cation exchange capacity & exchangeable cations		P	Cool to 4ºC	6 months
Cyanide		P, G	Cool to 4ºC	Extraction 7 days, Analyse within 14 days
Electrical conductivity		P, G	Cool to 4ºC	Extraction 7 days, Analyse within 28 days
Fluoride-total		PB	Cool to 4ºC	7 days
Moisture Content (7)		P, G	Cool to 4ºC	7 days
Particle Size		PB	Ambient	Not Specified
pH		P, G	Cool to 4ºC	Extraction 7 days, Analysis 6 hours
Sulfate		P, G	Cool to 4ºC	Extraction 7 days, Analysis 28 days
Sulfur or Sulfide - total		PB	Cool to 4ºC	Extraction 7 days, Analysis 28 days
Organic Carbon / Matter		G	Cool to 4ºC	7 days
TOC	Option 1	G	Cool to 4ºC	Dry within 7 days, Analysis 180 days
	Option 2	G	Freeze	Analyse within 180 days
Chromium VI (water soluble)		P, G	Cool to 4ºC	Extract within 28 days, Analyse within 24 hours in unpreserved extracts or 7 days in NaOH Preserved extracts.
Chromium VI (Alkali Digestion)		P, G	Cool to 4ºC	Extract within 28 days, Analyse within 7 days.
General		P, G	Cool to 4ºC	Not Specified
General		P, G	Cool to 4ºC	6 months
Mercury		P, G	Cool to 4ºC	28 days

Methyl Mercury	Glass (T)	Dark; Cool to 4°C or freeze < -10°C.	40 days at 4°C; 8 months if frozen.
Organics - Semi-volatile Compounds (SVOCs)			
Carbamates	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Chlorinated Hydrocarbons	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Dioxins	Glass (T)	Cool to 4ºC	Extract within 1 year, Analyse within 1 year
Explosives	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Herbicides (Phenoxy Acid)	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Organochlorine Pesticides	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Organophosphorus Pesticides	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
PCBs	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Petroleum Hydrocarbons (C_{10}-C_{36})	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Phenols	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Phthalate Esters	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Polyaromatic Hydrocarbons (PAHs)	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
Tributyl Tin (TBT)	Glass (T)	Cool to 4ºC	Extract within 14 days, Analyse within 40 days
BTEX	Glass (T)	Cool to 4ºC (ZH)	14 days
Halogenated Aliphatics	Glass (T)	Cool to 4ºC (ZH)	14 days
Halogenated Aromatics	Glass (T)	Cool to 4ºC (ZH)	14 days
Monocyclic Aromatics (MAHs)	Glass (T)	Cool to 4ºC (ZH)	14 days
Petroleum Hydrocarbons (C_6-C_9)	Glass (T)	Cool to 4ºC (ZH)	14 days
Trihalomethanes (THMs)	Glass (T)	Cool to 4ºC (ZH)	14 days
VOC	Glass (T)	Cool to 4ºC (ZH)	14 days
Acid Sulphate Soils			

SPOCAS, TOS,	Option 1	PB (exclude air)	Freeze	Indefinite
	Option 2	PB (exclude air)	Cool to 4ºC	24 hours
Chromium Suite	Option 3	PB (exclude air)	Dry at 80ºC	Indefinite

SOLIDS	SOLIDS	SOLIDS	SOLIDS
PARTICLE SIZE or ASBESTOS	**SOIL PARAMETERS**	**SEDIMENT PARAMETERS**	**ACID SULFATE SOILS**
Sample Container	**Sample Container**	**Sample Container**	**Sample Container**
60mL or 500mL heavy duty zip lock plastic bag	150ml jar/Teflon lined lid or 200ml plastic for PFAS only	250mL Glass Jar, Teflon Lined Lid	250mL Plastic Bag
Preservation	Preservation	Preservation	Preservation
Nil	Nil, Chill to ≤6°C	Nil, Chill to ≤6°C	Nil, Freeze or submit within 24 hours of sampling
Analytes	**Analytes**	**Analytes**	**Analytes**
Particle Size Distribution or Asbestos	All parameters excluding ASS, Sizings and Asbestos. Soil jars minus Teflon liner are suitable for PFAS. Please provide separate jars for Dioxins, PBDEs, Explosives, ZHE Extracts or Herbicides.	Common NAGD organic and inorganic suites excluding sizing, Ecotox and Elutriates	SPOCAS Chromium Suite CRS TOS NAPP/NAG
Notes	**Notes**	**Notes**	**Notes**
Sizing/PSD: 500ml bag Asbestos (transport in sealed rigid container) Potential ACM or soils Pres/ Abs: 60ml bag Friable Asbestos Quantitation 500ml bag or 10L buckets	150mL jar is sufficient for all routine soil analysis + one ASLP or TCLP leach. Two jars are recommended for multiple leachates including ZHE	Contact ALS for Elutriate and Pore water testing sample requirements	Unless requested otherwise Acid Sulfate Soils will be automatically dried and prepared upon receipt to facilitate extended holding times
Holding Time	**Holding Time**	**Holding Time**	**Holding Time**
Indefinite	Inorganics generally: 7-28 days. Mercury and Hex' Chromium: 28 days; VOC/SVOC: 7-14 days; Other metals: 6 months	Generally 14 days except Mercury (28 days) and Metals (6 months)	Unfrozen – 24 hours Frozen – indefinite
BLACK ON WHITE	**ORANGE**	**ORANGE**	**GREEN**

SAMPLE CONTAINER REQUIREMENTS

Client:		**Date Required by Client:**
Contact:		**Time Required by Client:**
Telephone:		**Laboratory Use ONLY**
Delivery Address:		**Date Received by :**
		Time Received by :
		***Courier Charge? Y / N**

QUALITY CONTROL SAMPLE CONTAINERS

Suggested Label Colour Code	**Container Type** (sample containers supplied with teflon lined lids)	**Test Parameter(s)**
Orange	1 x **150ml** wide mouth glass jar	Trip **BLANK SOIL** (BTEX)
Orange	**Trip/Field Spike (soil) – duplicate jars (control and field spike) of sand spiked with unleaded petrol. Both control and field spike to be analysed for TRH/BTEX** (provided under CoC conditions with ice)	Trip **SPIKE SOIL**$^{\text{(Min. 24hr notice required)}}$ (C_6-C_9, BTEX compounds).
Purple	2 x **40ml** Amber glass vial (Sulfuric Acid preserved) Trip Blank	Trip **BLANK WATER** (BTEX)
Purple	2 x **40ml** Amber glass vial (Sulfuric Acid preserved) Trip Spike (provided under CoC conditions with ice)	Trip **SPIKE WATER** (BTEX)
-	1 x **500mL** Amber glass bottle	Rinsate: Semi-Volatile Organics
-	1 x **1L** Opaque plastic ‘natural’ bottle	Rinsate: Metals and Inorganics
-	1 x **500ml** Amber glass bottle	Rinsate: Volatile Organics & TOC/DOC

SOIL/SLUDGE/SEDIMENT SAMPLE CONTAINERS

Suggested Label Colour Code	**Container Type** (sample containers supplied with teflon lined lids)	**Test Parameter(s)**
Orange	1 x **150ml** wide mouth glass jar	TRH/BTEXN/PAH & Metals, **or** **ZHE only, or** Dioxins **or** TBT plus TOC, **or** Herbicides, PFOS/PFOA, Ultra trace OC/OP/PCB **or** PBDE’s
Orange	1 x **250ml** wide mouth glass jar	Test parameters **including TCLP and ZHE**
Green	1 x **250g** resealable plastic bag (**samples should be frozen**)	Acid Sulfate Soils
Black on White	1 x **250g** resealable plastic bag	Asbestos, Particle Sizing
	1 x **100g** paper bag	Total Sulfur or Total Fluoride, Sulfide
Black	1 x **120ml** sterile wide mouth plastic jar	Microbiological tests
Turquoise	1 x **4 L** clear glass (*$CuSO_4$ solution*)	Dust Deposition gauges

SAMPLE CONTAINERS (WATER)

Volumes listed below are recommended based on "clean" waters

INORGANICS

Suggested Label Colour Code	Container Type (*Preservation*)	Test Parameter(s)
Green	1 x **250ml** plastic (*none*)	**Sample Collection Pocket Guide Suite:1** Alkalinity, EC, pH, Cations, Cl, SO4, F, Hardness, Nitrite, Nitrate, Reactive P, Silica, plus TDS(Calc.only), Acidity
Green	1 x **500ml** plastic (*none*)	**Sample Collection Pocket Guide Suite:2** Suite 1(above) + Colour, Turbidity, std. level TDS, TSS
Green	1 x **1,000ml** plastic (*none*)	**Sample Collection Pocket Guide Suite 3:** Suite 1 + 2 (as above) + Low level TDS, TSS + BOD
Green	1 x **1,000ml** White plastic (*none*)	Chlorophyll a (Standard LOR)
Green	1 x **1,000ml** White plastic (*none*)	Asbestos
Light Green & White stripe	1 x **60ml** plastic *(none)*	Total Nitrogen and Total Phosphorus – **ULTRA TRACE**
Turquoise & White stripe	1 x **60ml** plastic *(none)*	Reactive P, Nitrate, Nitrite, Ammonia, Silica (Field filtered) – **ULTRA TRACE**
Yellow	1 x **125ml** plastic (*Zinc Acetate and NaOH*)	Sulfide
Yellow & Light Blue	2 x **125mL** plastic bottles; Yellow (*Zinc Acetate and NaOH)* plus Light Blue *(Aluminum Chloride*)	Unionized Sulfide
Light Orange	1 x **250ml** plastic (*EDTA and Zinc Acetate*)	Sulfite, Thiosulfate
Brown & Green Stripe	1 x **500ml** Amber glass (*HCHO to be added upon receipt at the laboratory*)$^{\text{NOTE 1}}$	Surfactants (NIS or MBAS)
Blue	1 x **250ml** White plastic (*NaOH*)	Total, Free and WAD Cyanide; Cyanate
Blue & White Stripe	1 x **250ml** White plastic Sulfide pretreatment bottle ($Pb(OAC)_2$)$^{\text{NOTE2}}$	Total, Free and WAD Cyanide; Cyanate
Purple	1 x **125ml** plastic (*Sulfuric acid*)	COD, Ammonia, TN, NOx, TKN, TP or Total Phenols
Purple	1 x **40ml** Glass vial (*Sulfuric acid*)	TOC
Purple	1 x **40ml** Glass vial (*Sulfuric acid*)	DOC (Field Filtered)
Purple	1 x **1,000ml** wide mouth glass jar (*Sulfuric acid*)	Oil & Grease

MICRO & ALGAE

Suggested Label Colour Code	Container Type (*Preservation*)	Test Parameter(s)
Grey	1 x **250ml** Sterile plastic jar/lid *(With* $Na_2S_2O_3$*)*	Multiple 'Micro' Tests
Dark Green	1 x **1,000ml** White plastic (*Lugol's solution*)	Algae

METALS & RADIONUCLIDES

Suggested Label Colour Code	Container Type (*Preservation*)	Test Parameter(s)
Red	1 x **60ml** plastic (*Nitric acid*)	Heavy Metals **Dissolved** (Field Filtered) or **Total**
Red & Green stripe	1 x **60ml** plastic *(none)* ***AIRFREIGHT OPTION***	Heavy Metals **Dissolved** (Field Filtered) or **Total**
Red on White	1 x **125ml** plastic (*Spec Pure nitric acid*)	ORC Metals in Fresh and Saline water **Dissolved** (Field Filtered) or **Total**
Red & Green stripe	1 x **125ml** plastic *(none)* ***AIRFREIGHT OPTION***	ORC Metals in Fresh and Saline water **Dissolved** (Field Filtered) or **Total**
Maroon on White	1 x **60ml** plastic (*Spec Pure HCl acid*)	As and Se Speciation **(Field Filtered)**
Maroon	1 x **60ml** plastic (*Hydrochloric acid*)	Ferrous Iron (Field Filtered)
Blue	1 x **60ml** plastic (*Sodium Hydroxide*)	Hexavalent Chromium **(extended holding time)** – Field filtration required for dissolved Hex' Cr
Red & Green stripe	1 x **1,000ml** plastic (*none*) ***AIRFREIGHT OPTION***	Gross alpha/ Gross beta
	2 x **1,000ml** plastic *(none)* ***AIRFREIGHT OPTION***	Radium 226, Radium 228
Purple	2 x **40ml** Amber vials *(Sulfuric Acid) (suitable for Air Freight)*	TPH/TRH(C6-C10) plus BTEX, BTEXN, VOCs, Alcohols, Gases **or** Methane **or** CWG (VOC) speciation
Orange	1 x **100ml** (unpres') Amber for primary analysis 2 x additional **100ml** Amber glass bottles for laboratory duplicates and matrix spikes.	***Standard level*** OC/OP/PCB plus ***Standard level*** PAHs plus ***standard level*** Phenols plus TRH(C_{10}-C_{40}) plus standard level SVOC (8270 list)
Orange	1 x **100ml** Amber glass *(unpres') includes QC*	***Herbicides including*** Glyphosate/AMPA, Phenoxy Acids, Amitrole, metsulfuron methyl, Carbamates and Diuron ***(Standard level) plus Ultra trace*** Multi-residue Pesticides Suite **(EP234) , or** Explosives ***(Standard level)***
Orange	1 x **500ml** Amber *(unpres')* for primary analysis 2 x additional **500ml** Amber glass bottles for laboratory duplicates and matrix spikes.	***Enhanced level or Ultra-trace*** PAHs plus any standard level TPH and SVOCs **or** TBT **or** ***Ultra trace*** *OC/OP/PCBs* **or** Synthetic Pyrethroids **or** HRAF: TPH Aliphatic/Aromatic Speciation/TPH(C_{10}-C_{40}) **or** CWG TRH Speciation (SVOC fractions only)
Orange	2 x **500ml** Amber glass *(unpres')* for primary analysis 4 x additional **500ml** Amber glass bottles for laboratory duplicates and matrix spikes.	Dioxins & Furans **or** PBDEs **or** ***Ultra trace*** Phenols **or** ***ultra trace*** phenols *and* any level PAHs/TRH **or** ***Super Ultra-trace*** *PAHs* + other std SVOCs/TRH
Grey	1 x **125ml** plastic (PTFE free) (unpres' *however $Na_2S_2O_3$ may be added for chlorinated water*)	PFOS & PFOA **or** Paraquat & Diquat
Brown & Green Stripe	1 x **500ml** Amber glass (*HCHO to be added upon receipt at the laboratory*)$^{\text{NOTE1}}$	Alkylphenol Ethoxylates
Orange	1 x **500ml** Amber glass *(unpres')* for primary analysis 2 x additional **500ml** Amber glass bottles for laboratory duplicates and matrix spikes.	***Ultra trace*** Explosives **or** ***Ultra trace*** Phenoxy Acid herbicides **or** Nitrocellulose **or** ***Low level*** Multi-residue screen by LC/MS **(EP209)**

APPENDIX E: EXAMPLES OF REMEDIATION TECHNOLOGIES

In the first instance, the PSA and DSA process will have identified the contaminants of concern and whether these are actually impacting the site. The DSA in particular will have defined areas that are impacted, both laterally and vertically. From this information, the selection of the appropriate technology/s may be carried out.

Some considerations and mainstream treatments are:

- Metals – cannot be broken down, suitable technologies are:
    - Reduction – the conversion of ionic versions of metals to their less harmful forms, for example, chromium 6 (both harmful and soluble) to chromium 3, usually followed by fixation,
    - Fixation - immobilising the metals in the soil matrix to prevent migration off-site and leaching to groundwater,
    - Removal and disposal – excavation and transportation to a hazardous waste landfill facility (may or may not require fixation treatment as part of this process),
    - Incorporation into other products – metals contaminated sand may be added to concrete or asphalt for roads construction, which is really fixation with beneficial use of the final product.

- Hydrocarbons, may be broken down, suitable technologies are:
    - Landfarming – the process of allowing the natural soil microbes to break down the hydrocarbons in the soil, either on-site or at a prepared off-site area. Landfarming can also be used for volatile substances where contaminated soil is spread and contaminants allowed to volatilize from the soil.
    - Enhanced bio-remediation – using a cultured microbe media and nutrient supplement under moisture and pH balanced and monitored conditions to rapidly degrade hydrocarbons, either on-site or off-site,
    - Removal and disposal – excavation and transportation to a hazardous waste landfill facility (may or may not require some treatment as part of this process),
    - Air sparging – the injection of high pressure air into the soil at depth in order to vaporise and remove volatile hydrocarbons in the air stream. Hydrocarbon emissions to the atmosphere will result, where this may present issues with safety, a soil vapour extraction system may be added to either condense the hydrocarbons from the off-gas or combust the off-gas to destroy the hydrocarbons,
    - Thermal treatment – the heating of the soil to drive off hydrocarbon compounds, may be carried out in-situ or ex-situ. In-situ is more suited to lighter, more volatile hydrocarbons and may be combined with soil vapour extraction. Ex-situ treatment may involve the use of high temperature rotary furnaces that can treat heavier hydrocarbon fractions. Often the off gases are then burnt in a secondary system for complete destruction,
    - Soil washing – the process of using a solvent or surfactant to wash the hydrocarbons from the soil grains. May be applied in-situ or ex-situ and may be followed by bio-remediation for a final clean-up.

- Pesticides and herbicides – may be broken down, some are difficult to treat, generally; OC pesticides have stronger bonds and the more chlorine the stronger, OP's are less persistent and may be readily degraded:
    - Alkaline hydrolysis – the process of raising the soil pH to about pH 12 by the addition of lime or another highly alkaline substance and keeping the soil moist. This breaks the bonds of the OC compounds and the residues mainly off-gas. OP's will be very quickly degraded under this soil pH. Note that the soil will be virtually sterilised by this process, so natural soil microbes will not be present to degrade residues, but will re-colonise over time (after the pH returns to normal) and by soil mixing with untreated soils.
    - Enhanced bio-remediation – the use of cultured microbes for the degradation of chemical compounds. This has been found effective on OC and OP compounds, under controlled ex-situ conditions in purpose built treatment systems. This is a specialist area and more suited to the treatment of a high volume of soil with otherwise expensive disposal as the only other option,
    - Thermal treatment – only ex-situ treatment in a furnace will be suitable, consideration of off-gas treatment is also warranted.

- PCB's – may be broken down; generally, PCB's have strong bonds but the more chlorine the stronger the bond. PCB's are usually added to oil for use in transformers so the hydrocarbons have to be considered as well. Laboratory analysis should list results across the range of PCB products allowing an assessment of the resistance to degradation:
    - Enhanced bio-remediation – the use of cultured microbes for the degradation of PCB compounds. Recent research has identified microbes that will degrade PCB compounds in controlled treatment systems, this is a specialist area,
    - Thermal treatment – only ex-situ treatment in a furnace will be suitable, consideration of off-gas treatment is also warranted.
- PFOS and PFOA – additives for the production of foam in fire-fighting applications. These compounds are extremely persistent in the environment, having no known half-life at this time and highly soluble:
    - Thermal treatment – only ex-situ treatment in a furnace system will be suitable, off-gas treatment is also required to ensure complete breakdown of the compounds by further heating of the exhaust gas stream to extremely high temperatures.
- MTBE, TBA and other petroleum oxygenate additives – oxygenate additives used to increase the octane rating of fuels, blended at up to 15% ratios. Usually do not persist in soils due to a high affinity with water, will wash out of the soil under rainfall conditions, but usually found in conjunction with other hydrocarbons:
    - Bioremediation - once thought to be immune to bioremediation but now found to naturally degrade, higher rate of degradation under aerobic conditions. May be treated in an ex-situ treatment system,
    - Soil washing – may be leached from the soil under controlled conditions, a suitable capture system (water extraction network) must be in place if remediating in-situ. Best carried out ex-situ on an impermeable surface, effluent may be treated (thermal or bioremediation) or disposed,
    - Air sparging – may be stripped from the soil and groundwater by air sparging, but need to be aware of the other hydrocarbon compounds that will also volatilise and enter any soil vapour capture system.
- Nutrients and fertilisers – excess nutrients may harm plant growth and have off-site impacts including promoting algal blooms when nutrients sorbed to dust particles are deposited in waterways and the ocean. Excess nutrient situations may be the result of effluent releases from intensive livestock farming:
    - Excavation and disposal – may be excavated and transported to a suitable hazardous waste landfill facility,
    - Excavation and treatment – the soil may be washed of soluble nutrients in a system similar to the soil washing process, however; the soil may be returned to the site and the leached nutrients may be saved for use,
    - Phyto-remediation – the use of plants to take up excess nutrients. Some plants are able to tolerate very high nutrient loads and take up considerable amounts of nutrients. Over time this will reduce the concentrations of nutrients in the soil making the soil suitable again for the intended crops.

While a range of contaminants and remediation technologies have been discussed above, new technologies are being developed all the time. The technologies listed above are a fraction of the number of current technologies, but the list has been limited since unusual technologies can take some time to be established and may require the engagement of specialist contractors to oversee sites. This guide is intended to be used by EAD staff and therefore only established technologies were considered. Where a contaminant type falls outside the range of types discussed here, EAD should research that contaminant and carry out trials to learn the techniques required.

Technology Selection

Initially, the selection of the technology is based on the compounds present in the soil, their concentrations, distribution and the final concentrations considered to be safe levels (the site criteria). In some cases, a mixture of compounds may be present on a single site and this may rule out some remedial options. It may be that remediation has to be carried out in steps, with a treatment for one contaminant completed and then a second treatment carried out for a secondary contaminant. In other cases, even where there are different contaminants present within a site, they may be in distinctly different areas of the site, allowing for the use of different technologies in different areas of the same site. The level of detail contained in the DSA should be sufficient to allow for such decisions to be made.

The secondary consideration is then which of the available technologies that may be used to remediate the site is the best choice (if more than one technology is available). Considerations then may be for:

- Time required – excavation and disposal is usually the fasted site remediation method, bio-remediation and phytoremediation methods may take from months to years, is an urgent remediation of the site required?
- Final remediation criteria – thermal treatment will usually achieve a very low residual concentration, but where this is not required, enhanced bio-remediation may be suitable with some residual contamination left to degrade after a required concentration criteria is achieved,
- Cost – excavation and disposal, particularly where large volumes of material are involved, may be very expensive and is directly related to the haul distance from the site to the disposal facility. On-site bioremediation and reuse may then be substantially cheaper since the microbes do the work and transport and disposal fees are not required. Health and safety considerations including odour, noise and dust may require the choice of a slower or more expensive technology over a cheaper or faster option,
- Available facilities – if no disposal facility is available then this will rule out the excavation and disposal option from consideration, leaving only other treatments. This also includes the provision of other items such as manpower, specific equipment and if treatment is being considered, the equipment required for the installation and operation of the treatment system. There may be a need for a high power electrical supply for the operation of some systems,
- Aesthetics (noise, dust and odour) – where the site is isolated, these factors may not be important, however if the site is in close proximity to homes and businesses and possibly tourist destinations, then this may impact the technology selection as well, in these cases, an in-situ technology (if available) may be selected,
- Health and safety – in the case of some contaminants, the transportation of contaminated soils on public roads, especially over long distances, may pose a high risk to the health and safety of members of the public. Within the site itself, there may be a health and safety concern for the wellbeing of the site workers during excavation works, especially where volatile contaminants are being remediated. Odour issues may not pose a health risk, but the perception of a health risk from something that has a bad or intense odour may be an overriding factor.

Since the process of determining the best technology may be complicated, it is useful to consider the development of a site specific technology matrix to rank all the variables and produce a robust evaluation. Even with a selection matrix, there may be more than one option that suits the remediation of the site and it may then be the judgement of the remediation manager that decides which technology to use. It may also be helpful to conduct field trials if there is sufficient time and base the selection on the actual results achieved in the real world situation.

After considering the available technologies and then the pro’s and con’s associated with each and arriving at a suitable technology, the remediation manager must then plan for the stages of works required (the methodology).

Remediation Methodology

While the technology gives an overall view of the manner by which the remediation of the site will be achieved, the methodology lays out the process for the actual site works to be organised for this to occur. Considerations for site works are:

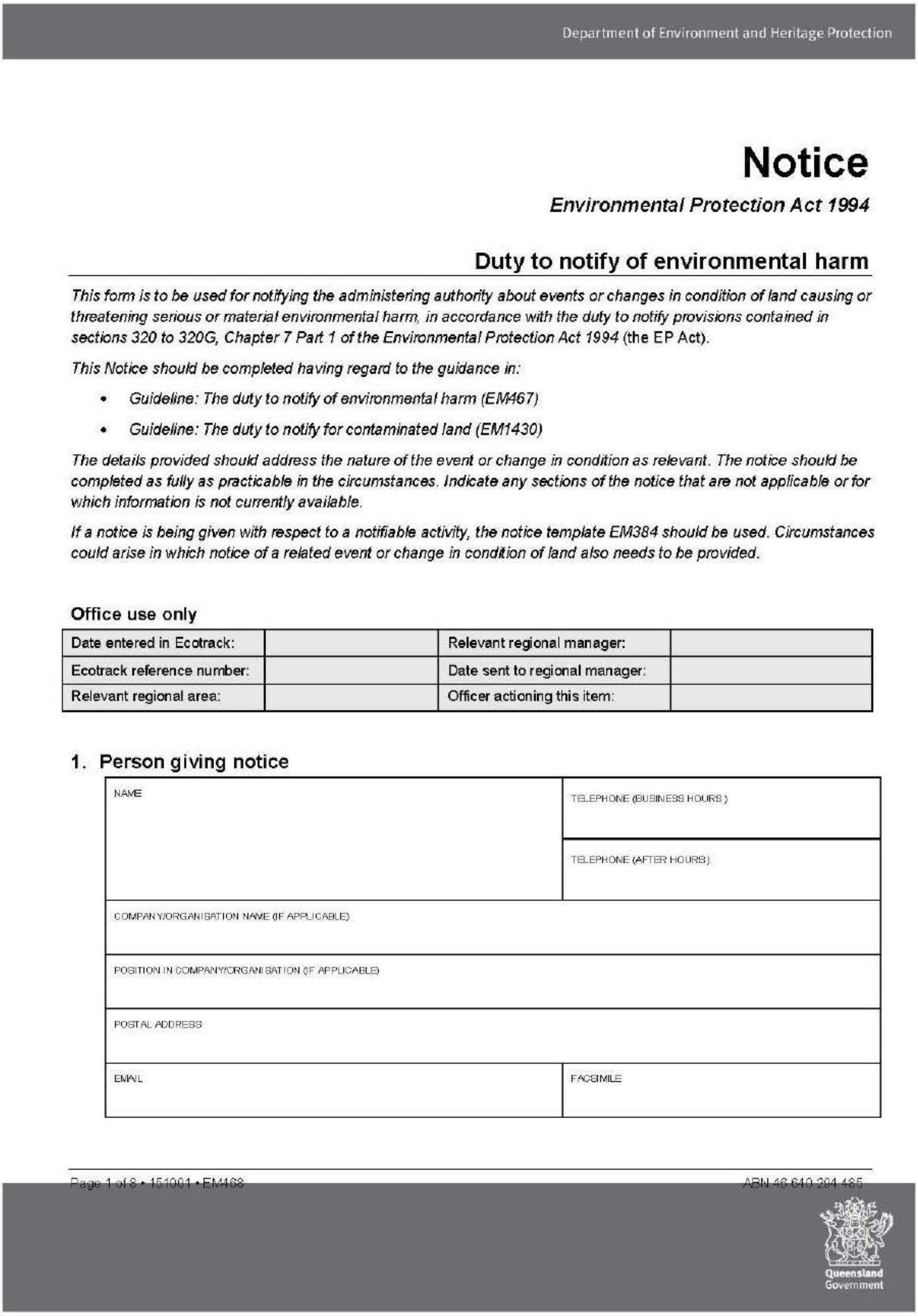
- Health and safety plan – this should be site specific although a single comprehensive template document may be drafted from which the relevant portions are copied to generate a site specific plan. The health and safety plan includes such things as:
    - Sign in and out register so the number of persons and their names is available in the event that persons need to be accounted for,
    - Induction section, which all site personnel must read and verify, preferable in a training class prior to commencing work,
    - Daily work assessment (tool box talk) where the details of the intended days works are discussed and potential problems and improvements are identified and noted,
    - Emergency procedures and muster point for a role call in the event of a site evacuation being triggered, and,
    - The specific circumstances that would trigger a site evacuation.

- Development of a work flow matrix or Gantt chart, setting out the stages of works in an easy to follow manner with timelines built-in,
- Checking with all suppliers to establish the required lead times for delivery of equipment and materials to the site to avoid remediation work delays and insertion of the lead times into the Gantt chart at specific trigger points. Also should consider de-mobilisation of equipment if there are lead times for the removal of equipment at the end of it's use,
- Where the transport of soil is being undertaken, planning for the number of trucks may be based on the distance to the disposal facility and back (turnaround time) and the time required to fill each truck to avoid either having trucks queued up at the site or the excavator standing idle for excessive amounts of time. Then the number of days required for the soil movement may be estimated from the volume to be removed, the number of truck movements that can be achieved in a single day and the volume able to be transported in each truck,
- Establishment of site facilities, especially for remote sites. A site office, break room, toilet and hand washing facilities should be present as a minimum requirement. Additional items such as first aid room and emergency eye wash and shower should also be considered.

Consideration should be given to field screening techniques, where available. These may assist in the real time delineation of the site contamination during remedial works, thus limiting soil disposal to only impacted soil and therefore achieving the remediation of the site in the most cost effective manner. Field screening tools have been developed for a range of contaminants:

- Metals – field portable X-ray devices, these read the concentrations of metals in the soil in parts per million, which equates to mg/kg,
- Hydrocarbons – PID and several variants, analyse the hydrocarbons present in vapour form in the headspace of a sample container. Not a direct correlation with the concentration of hydrocarbons in soil but an indication of the presence of volatile hydrocarbons in the soil. An Australian company has just released an instrument that can measure concentrations of hydrocarbons in soil with accuracy,
- Asbestos – near infra-red light is used to identify asbestos fibres present even in a bonded cement matrix, that instrument will indicate the first asbestos type it encounters on it's list, but others may also be present,
- OC's and OP's – immuno-assay kits are available that can determine the presence of herbicide and pesticide residues in soils; these are able to obtain low levels of detection but require training and trials for confidence in the results. Not an instant result, may take up to 24 hrs.

APPENDIX F: EXAMPLES OF CONTAMINATED LAND FORMS



Department of Environment and Heritage Protection

Notice

Environmental Protection Act 1994

Duty to notify of environmental harm

This form is to be used for notifying the administering authority about events or changes in condition of land causing or threatening serious or material environmental harm, in accordance with the duty to notify provisions contained in sections 320 to 320G, Chapter 7 Part 1 of the Environmental Protection Act 1994 (the EP Act).

This Notice should be completed having regard to the guidance in:

- *Guideline: The duty to notify of environmental harm (EM467)*
- *Guideline: The duty to notify for contaminated land (EM1430)*

The details provided should address the nature of the event or change in condition as relevant. The notice should be completed as fully as practicable in the circumstances. Indicate any sections of the notice that are not applicable or for which information is not currently available.

If a notice is being given with respect to a notifiable activity, the notice template EM384 should be used. Circumstances could arise in which notice of a related event or change in condition of land also needs to be provided.

Office use only

Date entered in Ecotrack:		Relevant regional manager:	
Ecotrack reference number:		Date sent to regional manager:	
Relevant regional area:		Officer actioning this item:	

1. Person giving notice

NAME	TELEPHONE (BUSINESS HOURS)
	TELEPHONE (AFTER HOURS)
COMPANY/ORGANISATION NAME (IF APPLICABLE)	
POSITION IN COMPANY/ORGANISATION (IF APPLICABLE)	
POSTAL ADDRESS	
EMAIL	FACSIMILE

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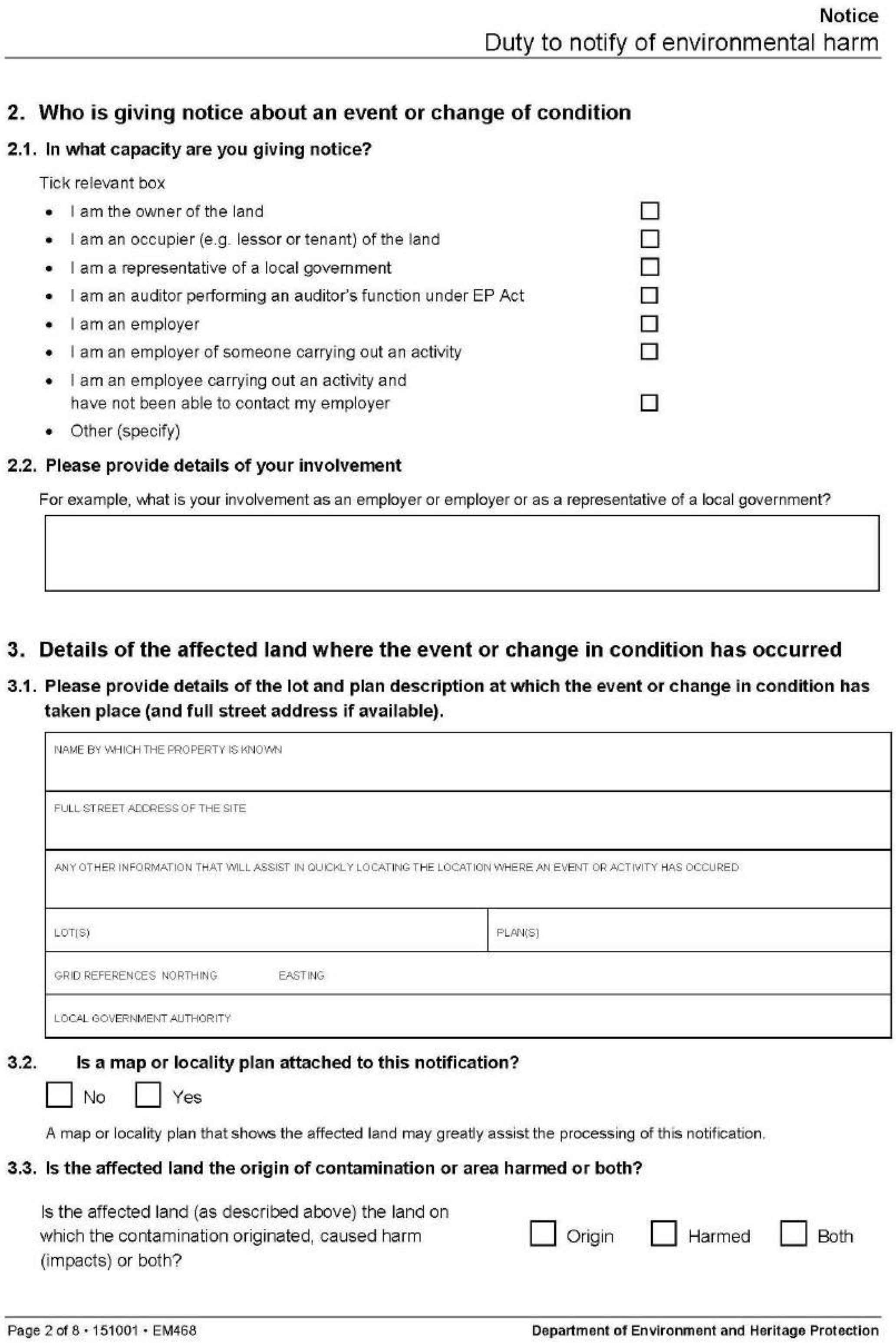
Queensland Government



Notice

Duty to notify of environmental harm

2. Who is giving notice about an event or change of condition

2.1. In what capacity are you giving notice?

Tick relevant box

- I am the owner of the land ☐
- I am an occupier (e.g. lessor or tenant) of the land ☐
- I am a representative of a local government ☐
- I am an auditor performing an auditor's function under EP Act ☐
- I am an employer ☐
- I am an employer of someone carrying out an activity ☐
- I am an employee carrying out an activity and have not been able to contact my employer ☐
- Other (specify)

2.2. Please provide details of your involvement

For example, what is your involvement as an employer or employer or as a representative of a local government?

3. Details of the affected land where the event or change in condition has occurred

3.1. Please provide details of the lot and plan description at which the event or change in condition has taken place (and full street address if available).

NAME BY WHICH THE PROPERTY IS KNOWN	
FULL STREET ADDRESS OF THE SITE	
ANY OTHER INFORMATION THAT WILL ASSIST IN QUICKLY LOCATING THE LOCATION WHERE AN EVENT OR ACTIVITY HAS OCCURED	
LOT(S)	PLAN(S)
GRID REFERENCES NORTHING	EASTING
LOCAL GOVERNMENT AUTHORITY	

3.2. Is a map or locality plan attached to this notification?

☐ No ☐ Yes

A map or locality plan that shows the affected land may greatly assist the processing of this notification.

3.3. Is the affected land the origin of contamination or area harmed or both?

Is the affected land (as described above) the land on which the contamination originated, caused harm (impacts) or both? ☐ Origin ☐ Harmed ☐ Both

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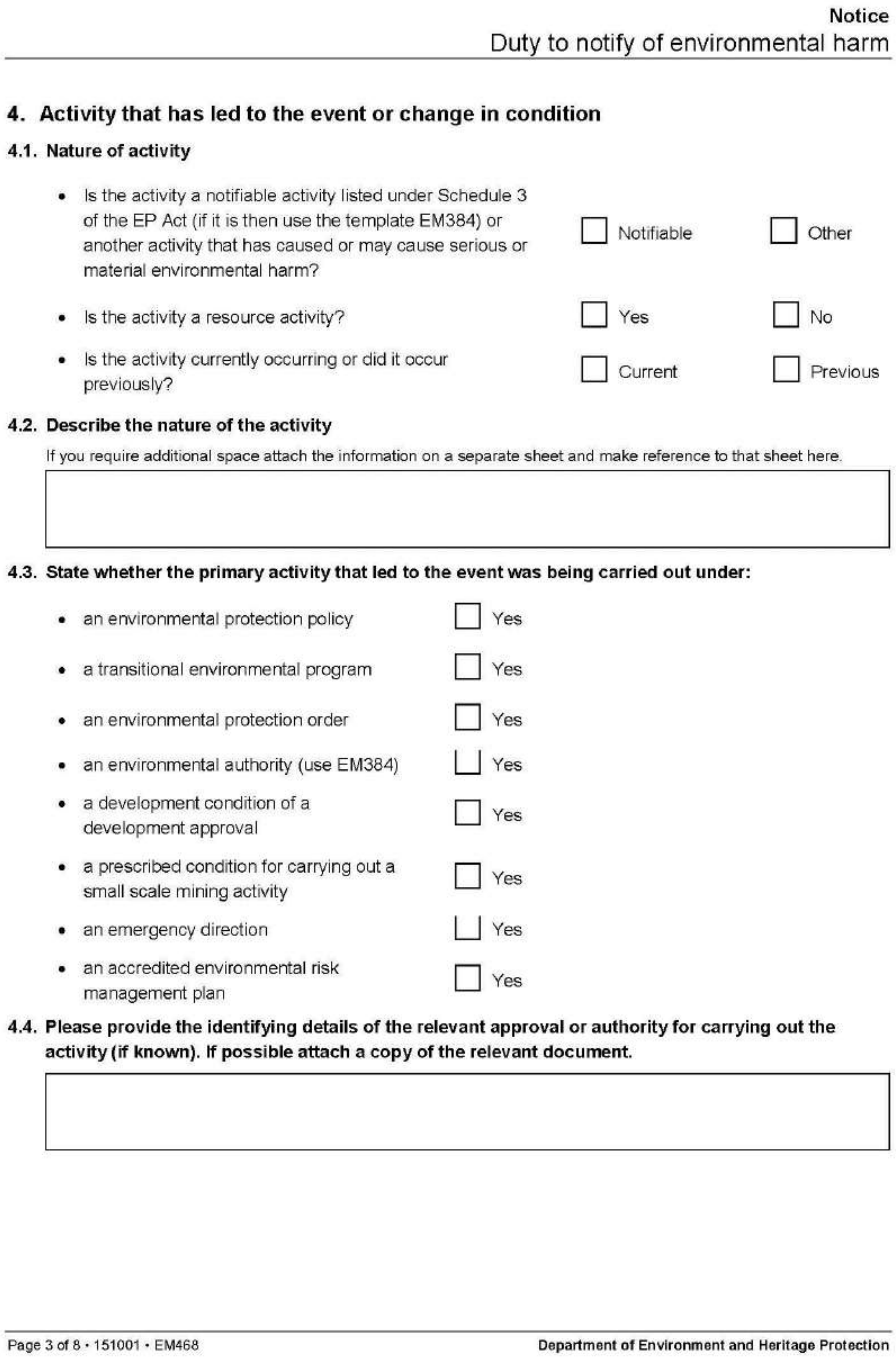
Department of Environment and Heritage Protection



Notice
Duty to notify of environmental harm

4. Activity that has led to the event or change in condition

4.1. Nature of activity

- Is the activity a notifiable activity listed under Schedule 3 of the EP Act (if it is then use the template EM384) or another activity that has caused or may cause serious or material environmental harm? ☐ Notifiable ☐ Other
- Is the activity a resource activity? ☐ Yes ☐ No
- Is the activity currently occurring or did it occur previously? ☐ Current ☐ Previous

4.2. Describe the nature of the activity

If you require additional space attach the information on a separate sheet and make reference to that sheet here.

4.3. State whether the primary activity that led to the event was being carried out under:

- an environmental protection policy ☐ Yes
- a transitional environmental program ☐ Yes
- an environmental protection order ☐ Yes
- an environmental authority (use EM384) ☐ Yes
- a development condition of a development approval ☐ Yes
- a prescribed condition for carrying out a small scale mining activity ☐ Yes
- an emergency direction ☐ Yes
- an accredited environmental risk management plan ☐ Yes

4.4. Please provide the identifying details of the relevant approval or authority for carrying out the activity (if known). If possible attach a copy of the relevant document.

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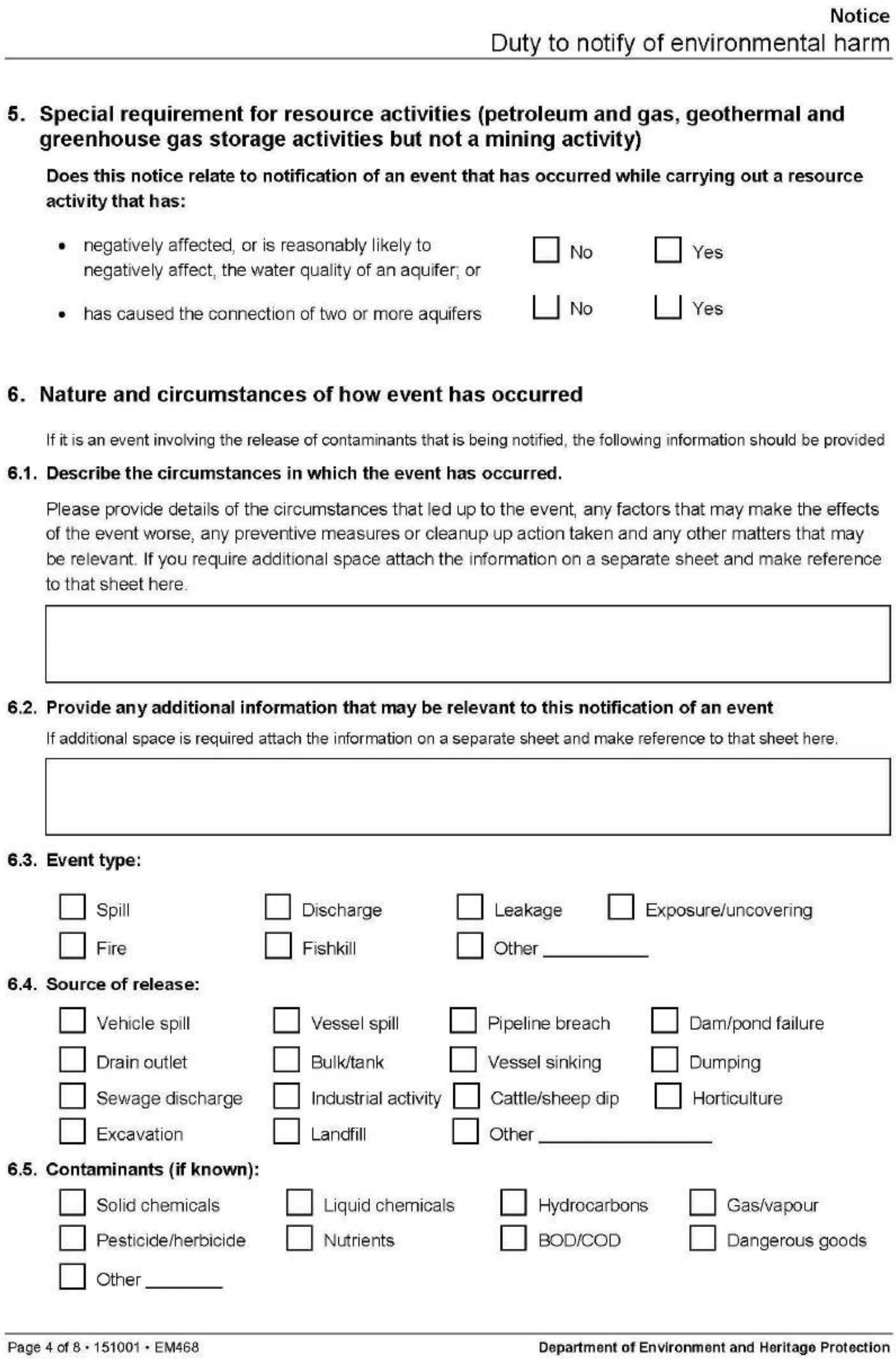
Department of Environment and Heritage Protection



Notice

Duty to notify of environmental harm

5. Special requirement for resource activities (petroleum and gas, geothermal and greenhouse gas storage activities but not a mining activity)

Does this notice relate to notification of an event that has occurred while carrying out a resource activity that has:

- negatively affected, or is reasonably likely to negatively affect, the water quality of an aquifer; or ☐ No ☐ Yes
- has caused the connection of two or more aquifers ☐ No ☐ Yes

6. Nature and circumstances of how event has occurred

If it is an event involving the release of contaminants that is being notified, the following information should be provided

6.1. Describe the circumstances in which the event has occurred.

Please provide details of the circumstances that led up to the event, any factors that may make the effects of the event worse, any preventive measures or cleanup up action taken and any other matters that may be relevant. If you require additional space attach the information on a separate sheet and make reference to that sheet here.

6.2. Provide any additional information that may be relevant to this notification of an event

If additional space is required attach the information on a separate sheet and make reference to that sheet here.

6.3. Event type:

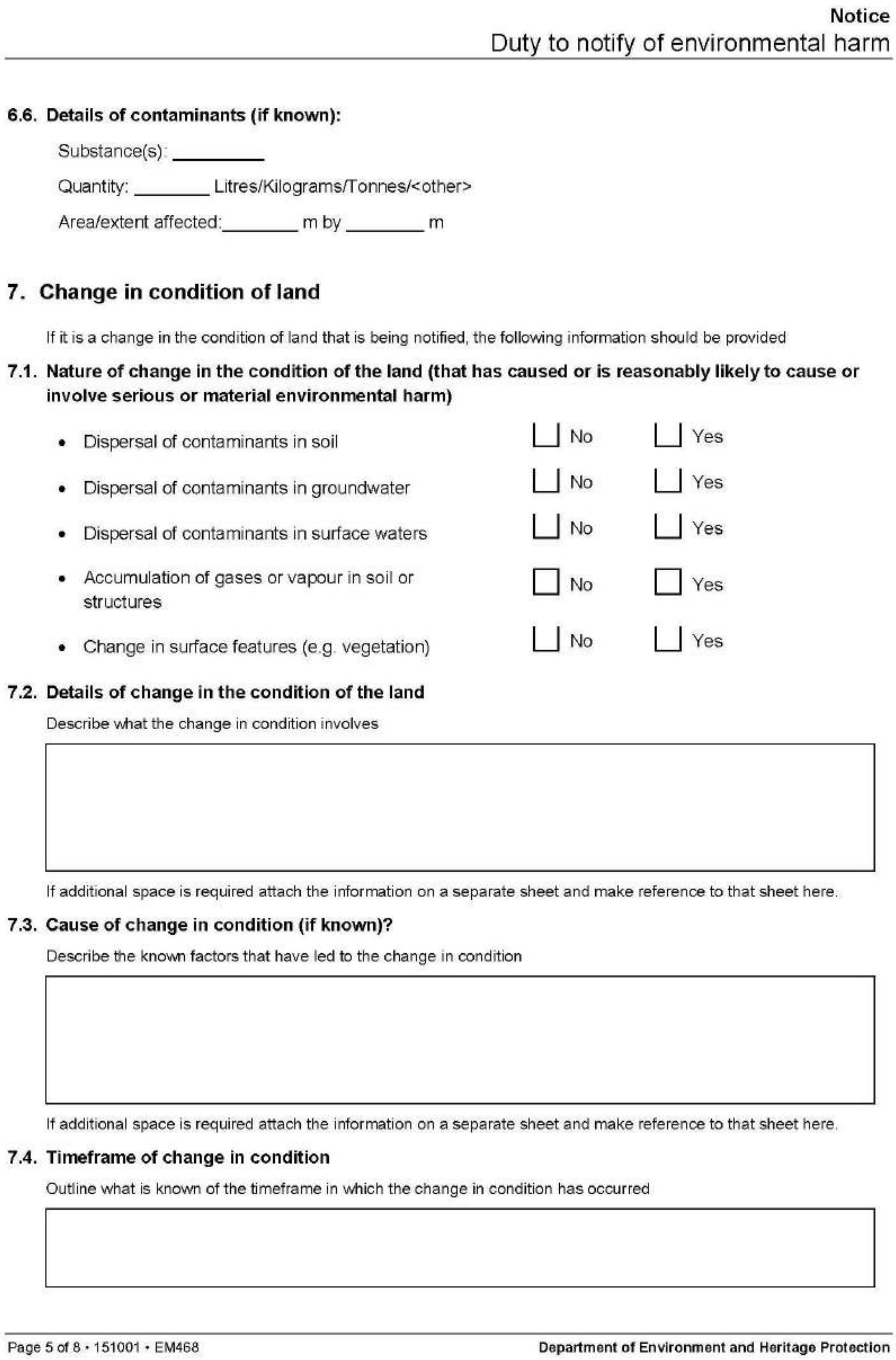
☐ Spill
☐ Fire
☐ Discharge
☐ Fishkill
☐ Leakage
☐ Other ___________
☐ Exposure/uncovering

6.4. Source of release:

☐ Vehicle spill
☐ Drain outlet
☐ Sewage discharge
☐ Excavation
☐ Vessel spill
☐ Bulk/tank
☐ Industrial activity
☐ Landfill
☐ Pipeline breach
☐ Vessel sinking
☐ Cattle/sheep dip
☐ Other ________________
☐ Dam/pond failure
☐ Dumping
☐ Horticulture

6.5. Contaminants (if known):

☐ Solid chemicals
☐ Pesticide/herbicide
☐ Other ________
☐ Liquid chemicals
☐ Nutrients
☐ Hydrocarbons
☐ BOD/COD
☐ Gas/vapour
☐ Dangerous goods



6.6. Details of contaminants (if known):

Substance(s): __________

Quantity: ________ Litres/Kilograms/Tonnes/<other>

Area/extent affected:________ m by ________ m

7. Change in condition of land

If it is a change in the condition of land that is being notified, the following information should be provided

7.1. Nature of change in the condition of the land (that has caused or is reasonably likely to cause or involve serious or material environmental harm)

• Dispersal of contaminants in soil	☐ No	☐ Yes
• Dispersal of contaminants in groundwater	☐ No	☐ Yes
• Dispersal of contaminants in surface waters	☐ No	☐ Yes
• Accumulation of gases or vapour in soil or structures	☐ No	☐ Yes
• Change in surface features (e.g. vegetation)	☐ No	☐ Yes

7.2. Details of change in the condition of the land

Describe what the change in condition involves

If additional space is required attach the information on a separate sheet and make reference to that sheet here.

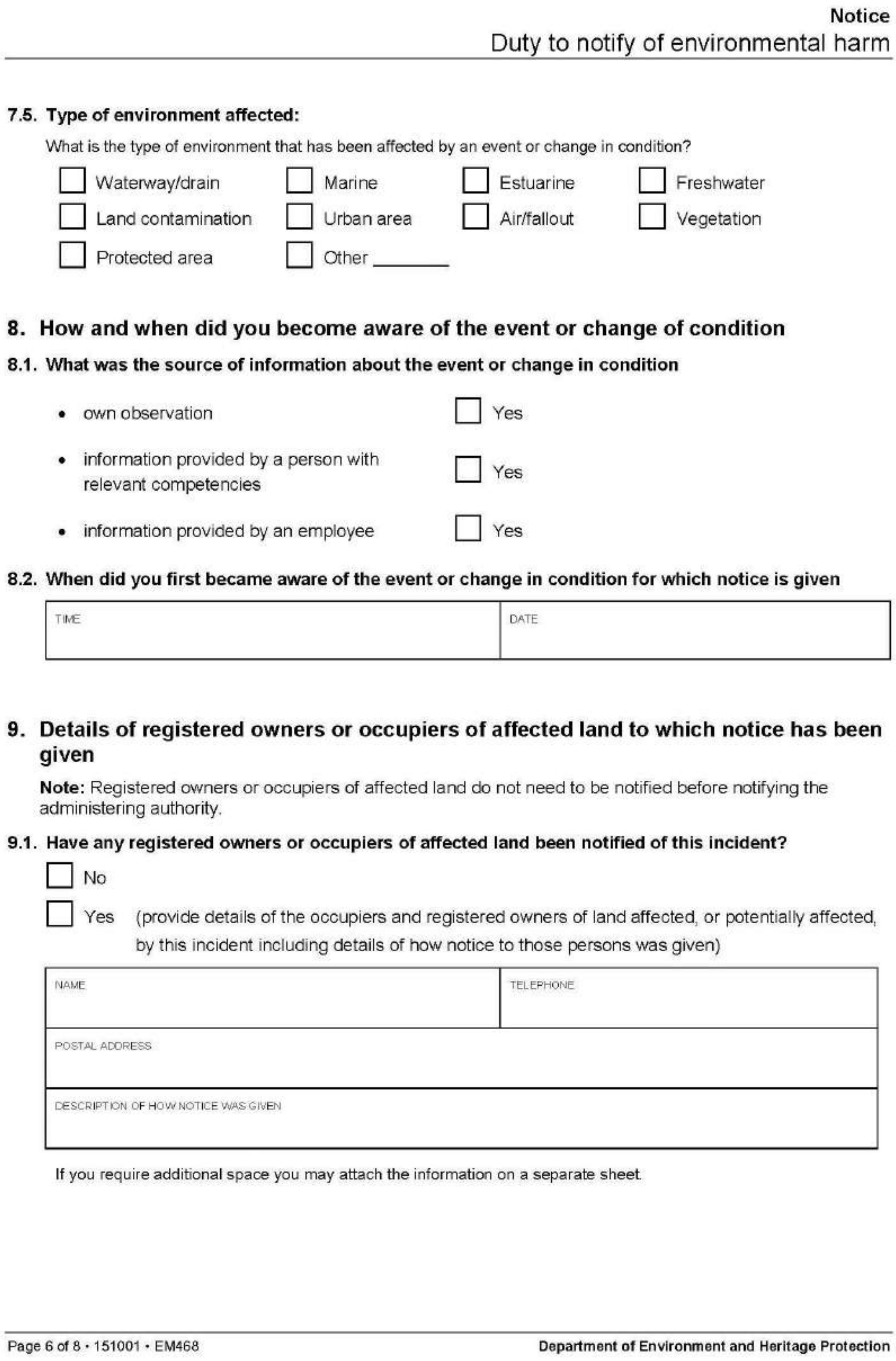
7.3. Cause of change in condition (if known)?

Describe the known factors that have led to the change in condition

If additional space is required attach the information on a separate sheet and make reference to that sheet here.

7.4. Timeframe of change in condition

Outline what is known of the timeframe in which the change in condition has occurred



Notice

Duty to notify of environmental harm

7.5. Type of environment affected:

What is the type of environment that has been affected by an event or change in condition?

☐ Waterway/drain ☐ Marine ☐ Estuarine ☐ Freshwater

☐ Land contamination ☐ Urban area ☐ Air/fallout ☐ Vegetation

☐ Protected area ☐ Other ________

8. How and when did you become aware of the event or change of condition

8.1. What was the source of information about the event or change in condition

- own observation ☐ Yes
- information provided by a person with relevant competencies ☐ Yes
- information provided by an employee ☐ Yes

8.2. When did you first became aware of the event or change in condition for which notice is given

TIME	DATE

9. Details of registered owners or occupiers of affected land to which notice has been given

Note: Registered owners or occupiers of affected land do not need to be notified before notifying the administering authority.

9.1. Have any registered owners or occupiers of affected land been notified of this incident?

☐ No

☐ Yes (provide details of the occupiers and registered owners of land affected, or potentially affected, by this incident including details of how notice to those persons was given)

NAME	TELEPHONE
POSTAL ADDRESS	
DESCRIPTION OF HOW NOTICE WAS GIVEN	

If you require additional space you may attach the information on a separate sheet.

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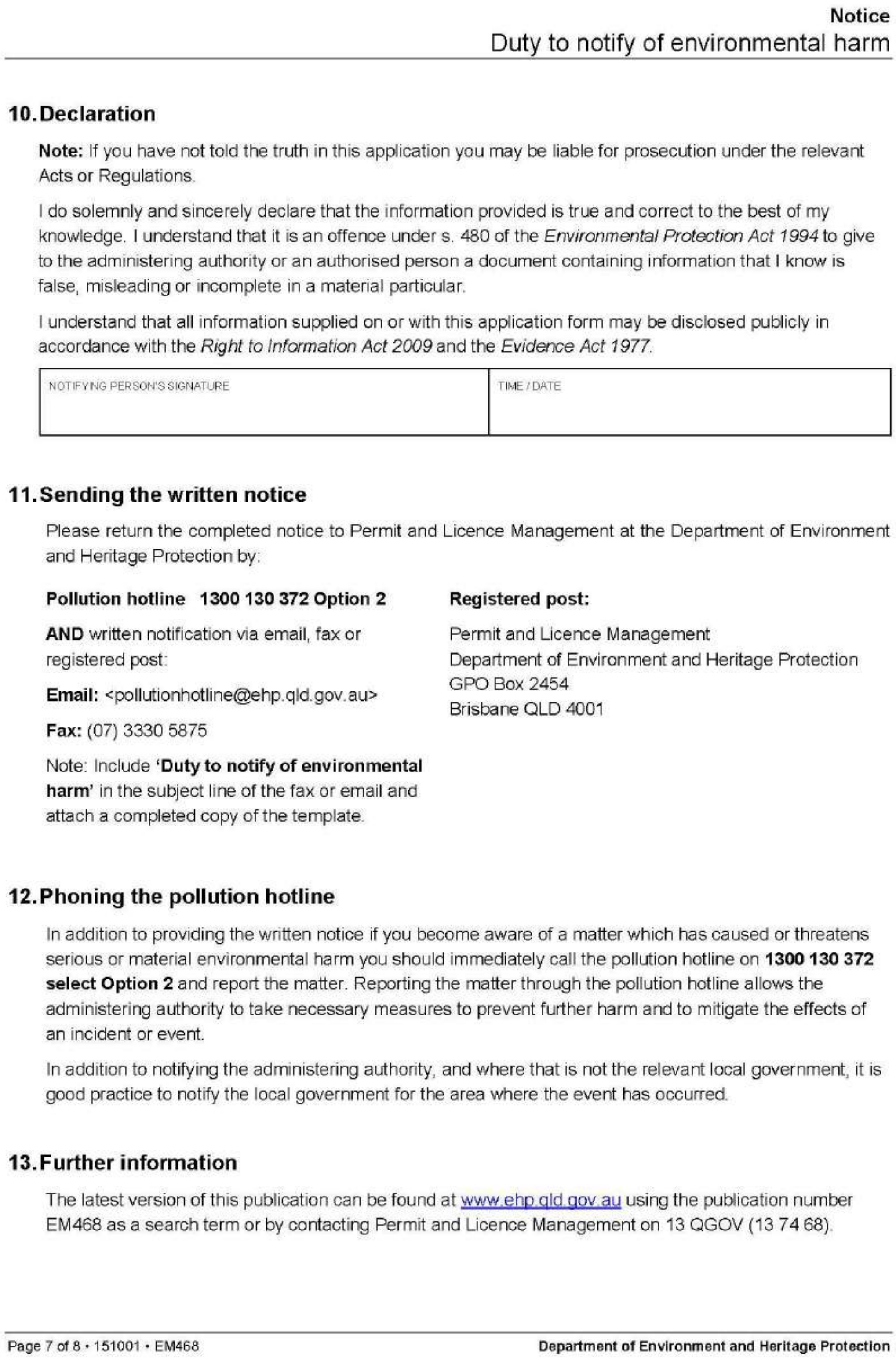
Department of Environment and Heritage Protection



Notice

Duty to notify of environmental harm

10. Declaration

Note: If you have not told the truth in this application you may be liable for prosecution under the relevant Acts or Regulations.

I do solemnly and sincerely declare that the information provided is true and correct to the best of my knowledge. I understand that it is an offence under s. 480 of the *Environmental Protection Act 1994* to give to the administering authority or an authorised person a document containing information that I know is false, misleading or incomplete in a material particular.

I understand that all information supplied on or with this application form may be disclosed publicly in accordance with the *Right to Information Act 2009* and the *Evidence Act 1977*.

NOTIFYING PERSON'S SIGNATURE	TIME / DATE

11. Sending the written notice

Please return the completed notice to Permit and Licence Management at the Department of Environment and Heritage Protection by:

Pollution hotline 1300 130 372 Option 2

AND written notification via email, fax or registered post:

Email: <pollutionhotline@ehp.qld.gov.au>

Fax: (07) 3330 5875

Note: Include **'Duty to notify of environmental harm'** in the subject line of the fax or email and attach a completed copy of the template.

Registered post:

Permit and Licence Management
Department of Environment and Heritage Protection
GPO Box 2454
Brisbane QLD 4001

12. Phoning the pollution hotline

In addition to providing the written notice if you become aware of a matter which has caused or threatens serious or material environmental harm you should immediately call the pollution hotline on **1300 130 372 select Option 2** and report the matter. Reporting the matter through the pollution hotline allows the administering authority to take necessary measures to prevent further harm and to mitigate the effects of an incident or event.

In addition to notifying the administering authority, and where that is not the relevant local government, it is good practice to notify the local government for the area where the event has occurred.

13. Further information

The latest version of this publication can be found at www.ehp.qld.gov.au using the publication number EM468 as a search term or by contacting Permit and Licence Management on 13 QGOV (13 74 68).

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Notice

Duty to notify of environmental harm

Privacy statement

The Department of Environment and Heritage Protection (EHP) will use the personal information collected on this form to investigate an incident that potentially caused or threatened to cause serious or material environmental harm, as provided for under ss. 320–320G of the *Environmental Protection Act 1994*. The information will only be accessed by authorised employees within EHP. The information provided on this form will not be otherwise be used or disclosed unless required or authorised by law. For information about privacy matters email: For queries about privacy matters email: privacy@ehp.qld.gov.au or telephone: (07) 3330 5436.

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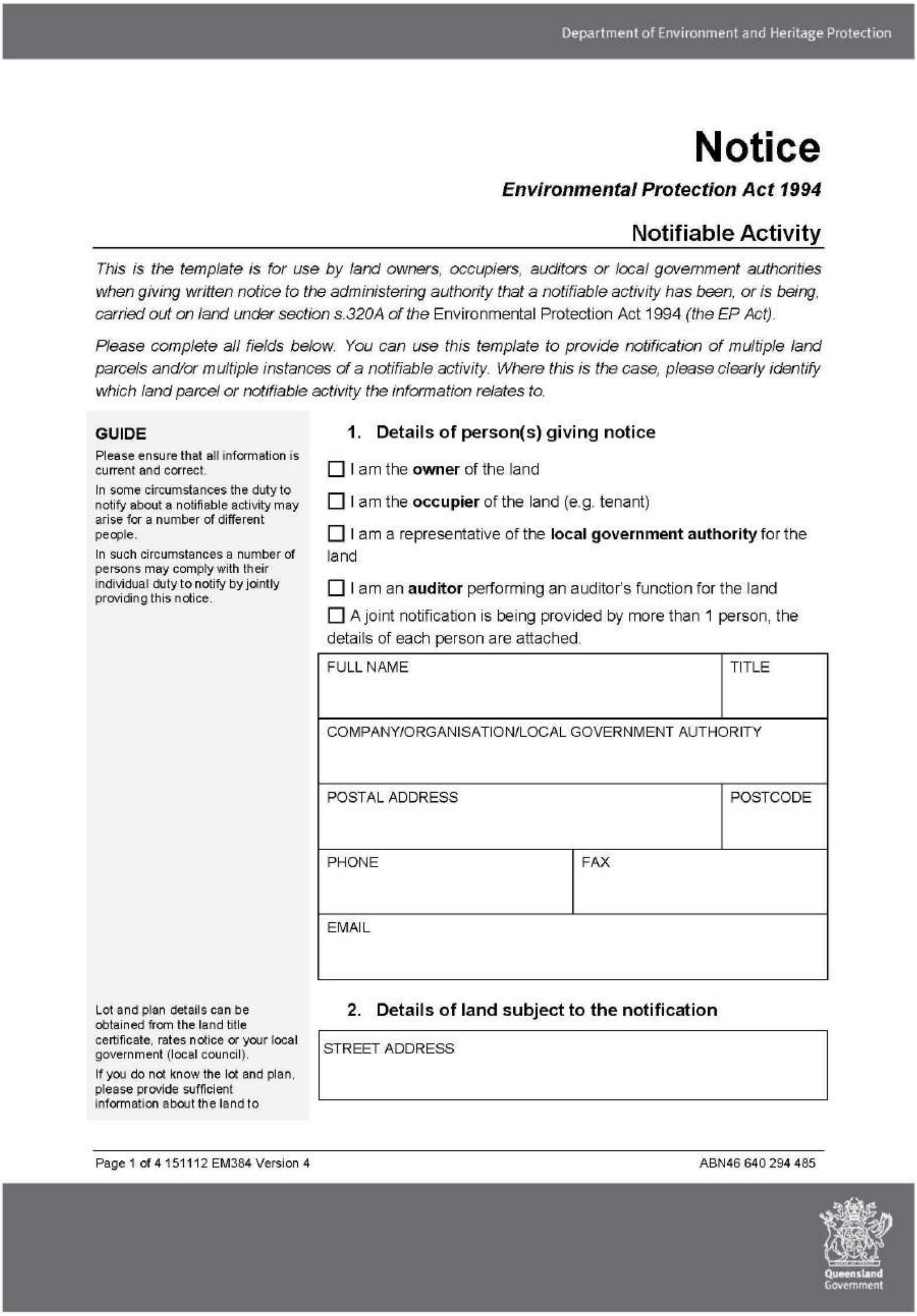

Department of Environment and Heritage Protection

Notice

Environmental Protection Act 1994

Notifiable Activity

This is the template is for use by land owners, occupiers, auditors or local government authorities when giving written notice to the administering authority that a notifiable activity has been, or is being, carried out on land under section s.320A of the Environmental Protection Act 1994 *(the EP Act).*

Please complete all fields below. You can use this template to provide notification of multiple land parcels and/or multiple instances of a notifiable activity. Where this is the case, please clearly identify which land parcel or notifiable activity the information relates to.

GUIDE

Please ensure that all information is current and correct.

In some circumstances the duty to notify about a notifiable activity may arise for a number of different people.

In such circumstances a number of persons may comply with their individual duty to notify by jointly providing this notice.

1. Details of person(s) giving notice

☐ I am the **owner** of the land

☐ I am the **occupier** of the land (e.g. tenant)

☐ I am a representative of the **local government authority** for the land

☐ I am an **auditor** performing an auditor's function for the land

☐ A joint notification is being provided by more than 1 person, the details of each person are attached.

FULL NAME	TITLE
COMPANY/ORGANISATION/LOCAL GOVERNMENT AUTHORITY	
POSTAL ADDRESS	POSTCODE
PHONE	FAX
EMAIL	

Lot and plan details can be obtained from the land title certificate, rates notice or your local government (local council).

If you do not know the lot and plan, please provide sufficient information about the land to

2. Details of land subject to the notification

STREET ADDRESS

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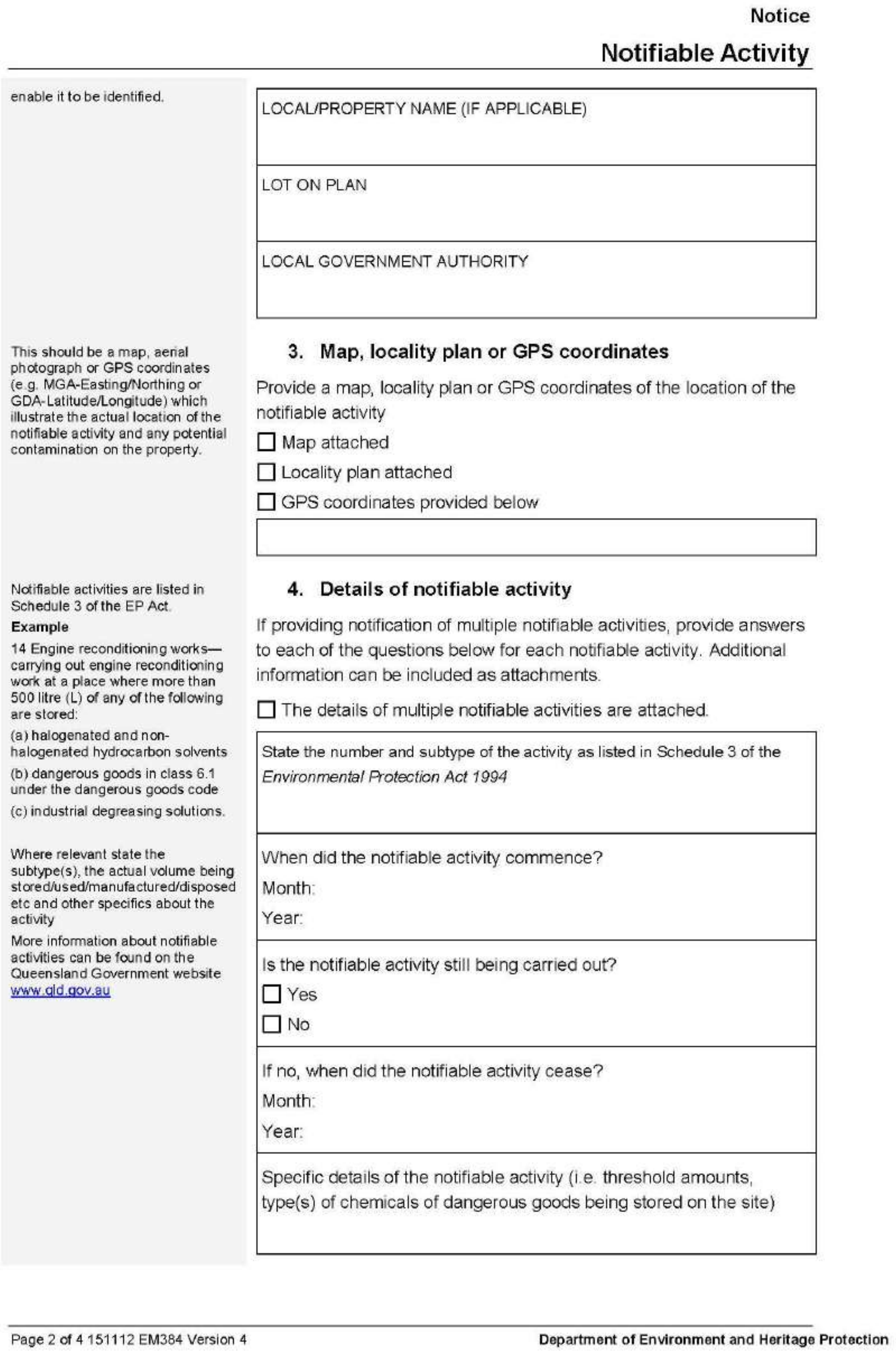
ABN46 640 294 485

Queensland Government



Notice

Notifiable Activity

enable it to be identified.

LOCAL/PROPERTY NAME (IF APPLICABLE)

LOT ON PLAN

LOCAL GOVERNMENT AUTHORITY

This should be a map, aerial photograph or GPS coordinates (e.g. MGA-Easting/Northing or GDA-Latitude/Longitude) which illustrate the actual location of the notifiable activity and any potential contamination on the property.

3. Map, locality plan or GPS coordinates

Provide a map, locality plan or GPS coordinates of the location of the notifiable activity

☐ Map attached
☐ Locality plan attached
☐ GPS coordinates provided below

Notifiable activities are listed in Schedule 3 of the EP Act.

Example

14 Engine reconditioning works—carrying out engine reconditioning work at a place where more than 500 litre (L) of any of the following are stored:

(a) halogenated and non-halogenated hydrocarbon solvents

(b) dangerous goods in class 6.1 under the dangerous goods code

(c) industrial degreasing solutions.

Where relevant state the subtype(s), the actual volume being stored/used/manufactured/disposed etc and other specifics about the activity

More information about notifiable activities can be found on the Queensland Government website www.qld.gov.au

4. Details of notifiable activity

If providing notification of multiple notifiable activities, provide answers to each of the questions below for each notifiable activity. Additional information can be included as attachments.

☐ The details of multiple notifiable activities are attached.

State the number and subtype of the activity as listed in Schedule 3 of the *Environmental Protection Act 1994*

When did the notifiable activity commence?
Month:
Year:

Is the notifiable activity still being carried out?
☐ Yes
☐ No

If no, when did the notifiable activity cease?
Month:
Year:

Specific details of the notifiable activity (i.e. threshold amounts, type(s) of chemicals of dangerous goods being stored on the site)

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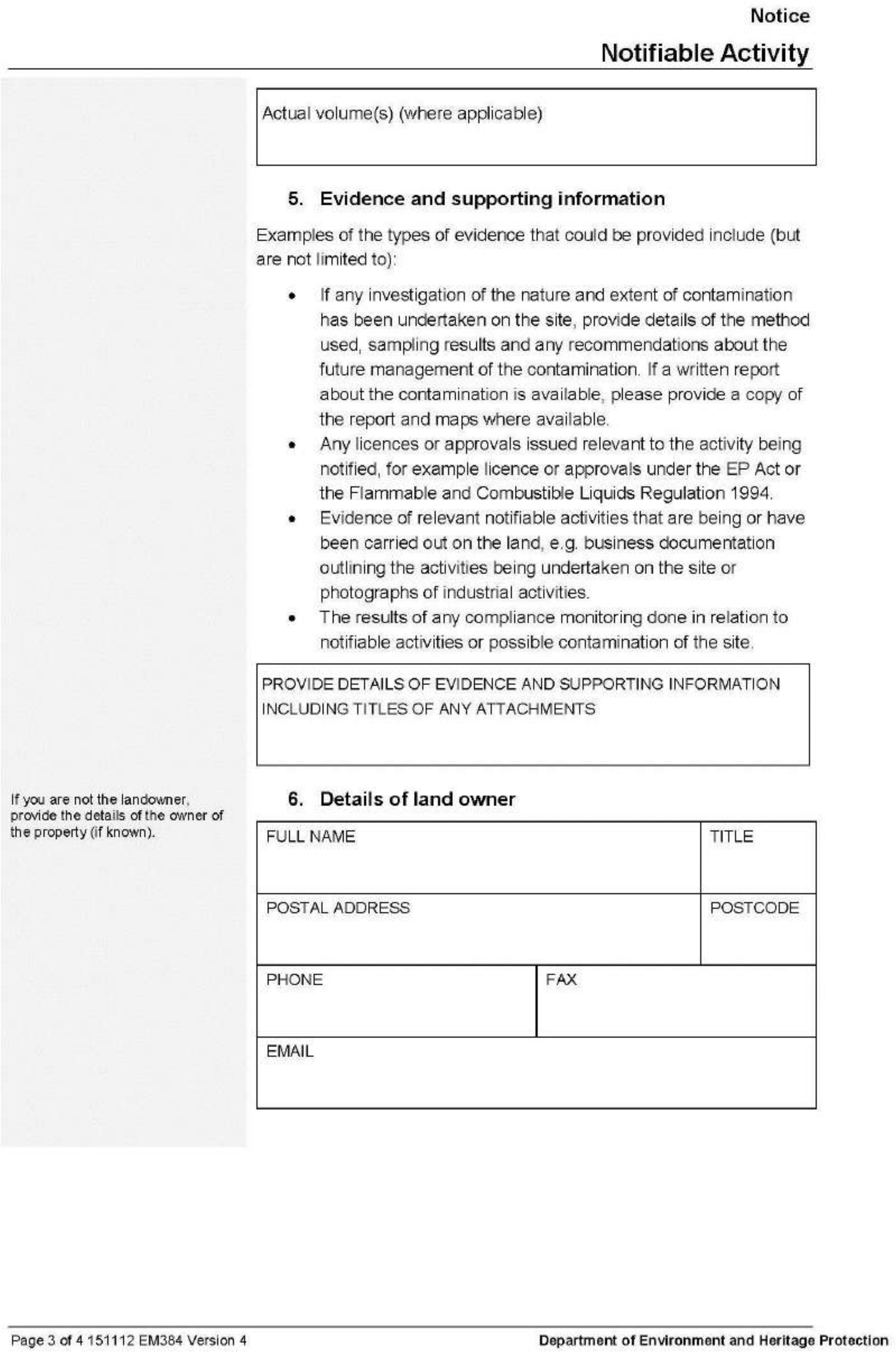

Notice

Notifiable Activity

Actual volume(s) (where applicable)

5. Evidence and supporting information

Examples of the types of evidence that could be provided include (but are not limited to):

- If any investigation of the nature and extent of contamination has been undertaken on the site, provide details of the method used, sampling results and any recommendations about the future management of the contamination. If a written report about the contamination is available, please provide a copy of the report and maps where available.
- Any licences or approvals issued relevant to the activity being notified, for example licence or approvals under the EP Act or the Flammable and Combustible Liquids Regulation 1994.
- Evidence of relevant notifiable activities that are being or have been carried out on the land, e.g. business documentation outlining the activities being undertaken on the site or photographs of industrial activities.
- The results of any compliance monitoring done in relation to notifiable activities or possible contamination of the site.

PROVIDE DETAILS OF EVIDENCE AND SUPPORTING INFORMATION INCLUDING TITLES OF ANY ATTACHMENTS

If you are not the landowner, provide the details of the owner of the property (if known).

6. Details of land owner

FULL NAME	TITLE
POSTAL ADDRESS	POSTCODE
PHONE	FAX
EMAIL	

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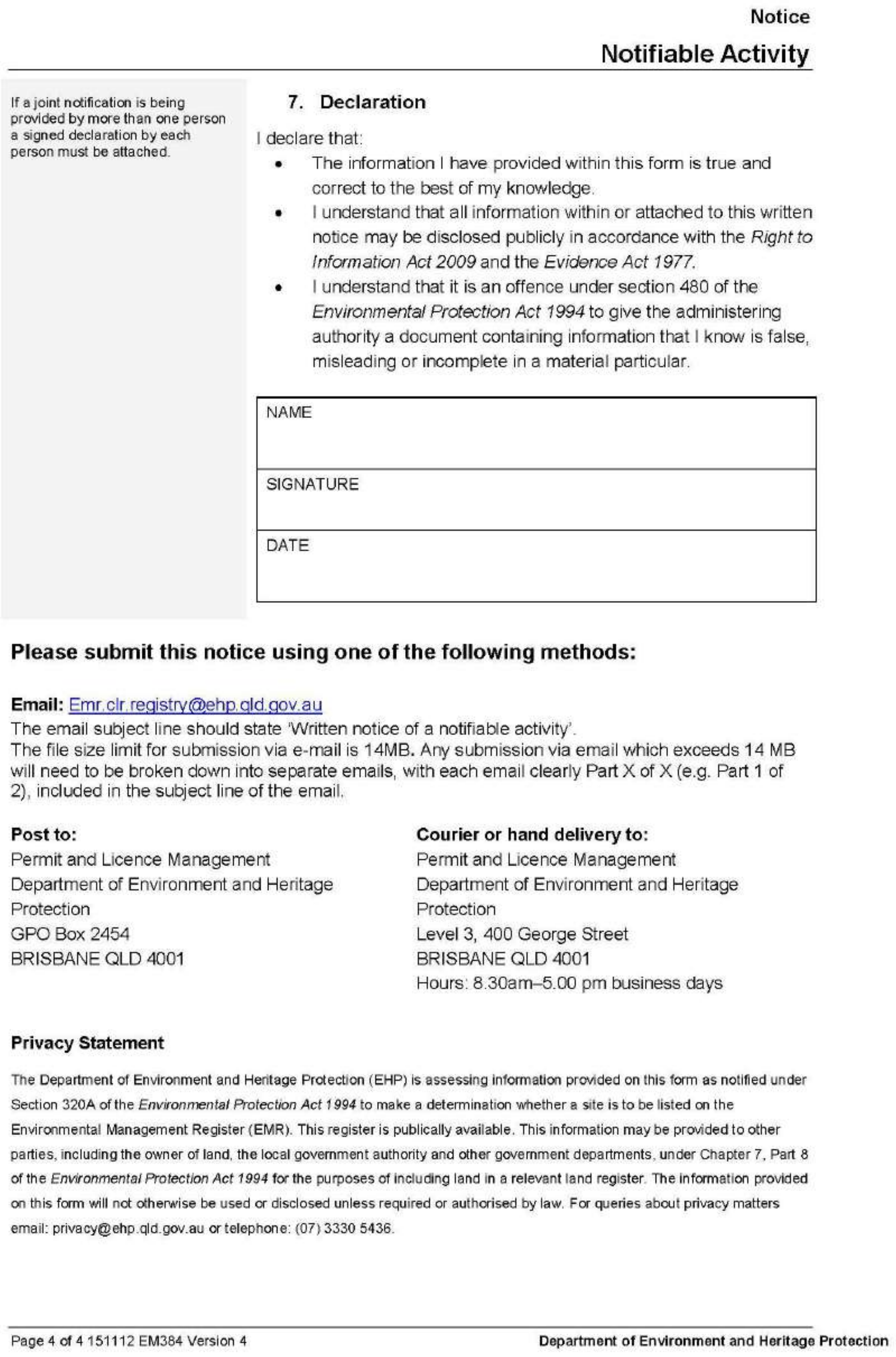
Department of Environment and Heritage Protection



Notice

Notifiable Activity

If a joint notification is being provided by more than one person a signed declaration by each person must be attached.

7. Declaration

I declare that:

- The information I have provided within this form is true and correct to the best of my knowledge.
- I understand that all information within or attached to this written notice may be disclosed publicly in accordance with the *Right to Information Act 2009* and the *Evidence Act 1977.*
- I understand that it is an offence under section 480 of the *Environmental Protection Act 1994* to give the administering authority a document containing information that I know is false, misleading or incomplete in a material particular.

NAME
SIGNATURE
DATE

Please submit this notice using one of the following methods:

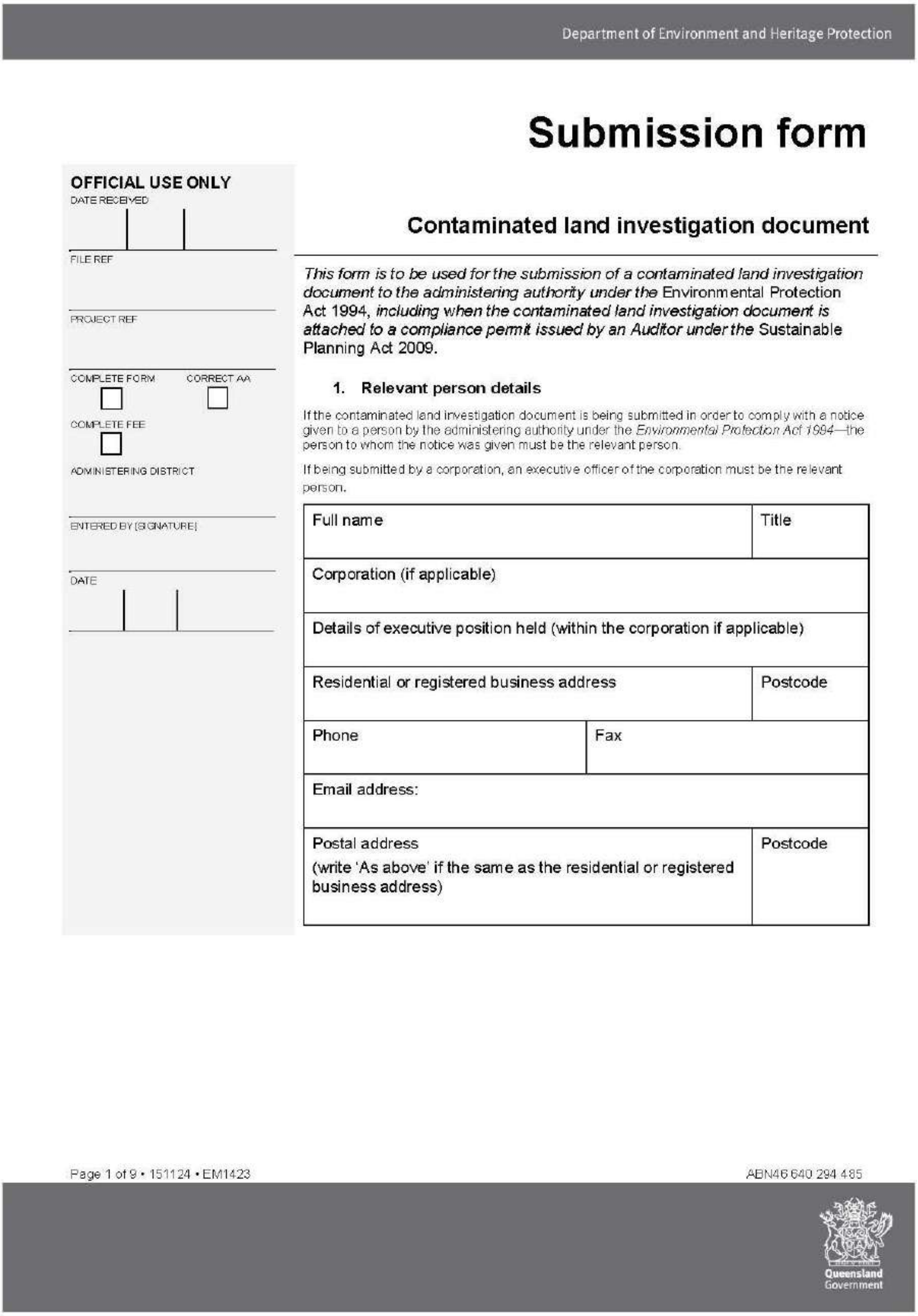
Email: Emr.clr.registry@ehp.qld.gov.au
The email subject line should state 'Written notice of a notifiable activity'.
The file size limit for submission via e-mail is 14MB**.** Any submission via email which exceeds 14 MB will need to be broken down into separate emails, with each email clearly Part X of X (e.g. Part 1 of 2), included in the subject line of the email.

Post to:
Permit and Licence Management
Department of Environment and Heritage Protection
GPO Box 2454
BRISBANE QLD 4001

Courier or hand delivery to:
Permit and Licence Management
Department of Environment and Heritage Protection
Level 3, 400 George Street
BRISBANE QLD 4001
Hours: 8.30am–5.00 pm business days

Privacy Statement

The Department of Environment and Heritage Protection (EHP) is assessing information provided on this form as notified under Section 320A of the *Environmental Protection Act 1994* to make a determination whether a site is to be listed on the Environmental Management Register (EMR). This register is publically available. This information may be provided to other parties, including the owner of land, the local government authority and other government departments, under Chapter 7, Part 8 of the *Environmental Protection Act 1994* for the purposes of including land in a relevant land register. The information provided on this form will not otherwise be used or disclosed unless required or authorised by law. For queries about privacy matters email: privacy@ehp.qld.gov.au or telephone: (07) 3330 5436.



Department of Environment and Heritage Protection

Submission form

OFFICIAL USE ONLY

DATE RECEIVED

FILE REF

PROJECT REF

COMPLETE FORM ☐ CORRECT AA ☐

COMPLETE FEE ☐

ADMINISTERING DISTRICT

ENTERED BY (SIGNATURE)

DATE

Contaminated land investigation document

This form is to be used for the submission of a contaminated land investigation document to the administering authority under the Environmental Protection Act 1994, *including when the contaminated land investigation document is attached to a compliance permit issued by an Auditor under the* Sustainable Planning Act 2009.

1. Relevant person details

If the contaminated land investigation document is being submitted in order to comply with a notice given to a person by the administering authority under the *Environmental Protection Act 1994*—the person to whom the notice was given must be the relevant person.

If being submitted by a corporation, an executive officer of the corporation must be the relevant person.

Full name	Title
Corporation (if applicable)	
Details of executive position held (within the corporation if applicable)	
Residential or registered business address	Postcode
Phone	Fax
Email address:	
Postal address (write 'As above' if the same as the residential or registered business address)	Postcode

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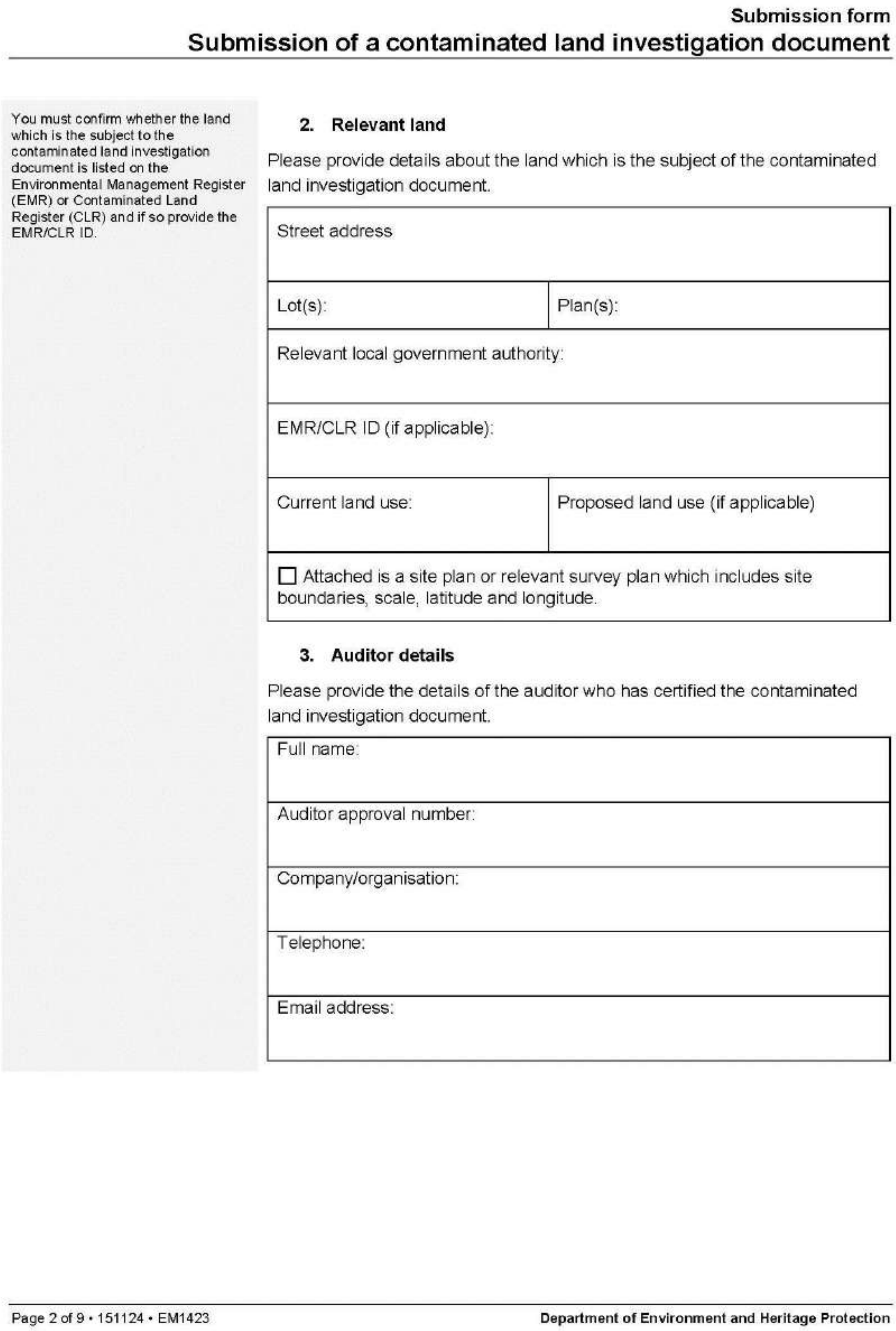
ABN 46 640 294 485

Queensland Government



Submission form

Submission of a contaminated land investigation document

You must confirm whether the land which is the subject to the contaminated land investigation document is listed on the Environmental Management Register (EMR) or Contaminated Land Register (CLR) and if so provide the EMR/CLR ID.

2. Relevant land

Please provide details about the land which is the subject of the contaminated land investigation document.

Street address	
Lot(s):	Plan(s):
Relevant local government authority:	
EMR/CLR ID (if applicable):	
Current land use:	Proposed land use (if applicable)
☐ Attached is a site plan or relevant survey plan which includes site boundaries, scale, latitude and longitude.	

3. Auditor details

Please provide the details of the auditor who has certified the contaminated land investigation document.

Full name:

Auditor approval number:

Company/organisation:

Telephone:

Email address:

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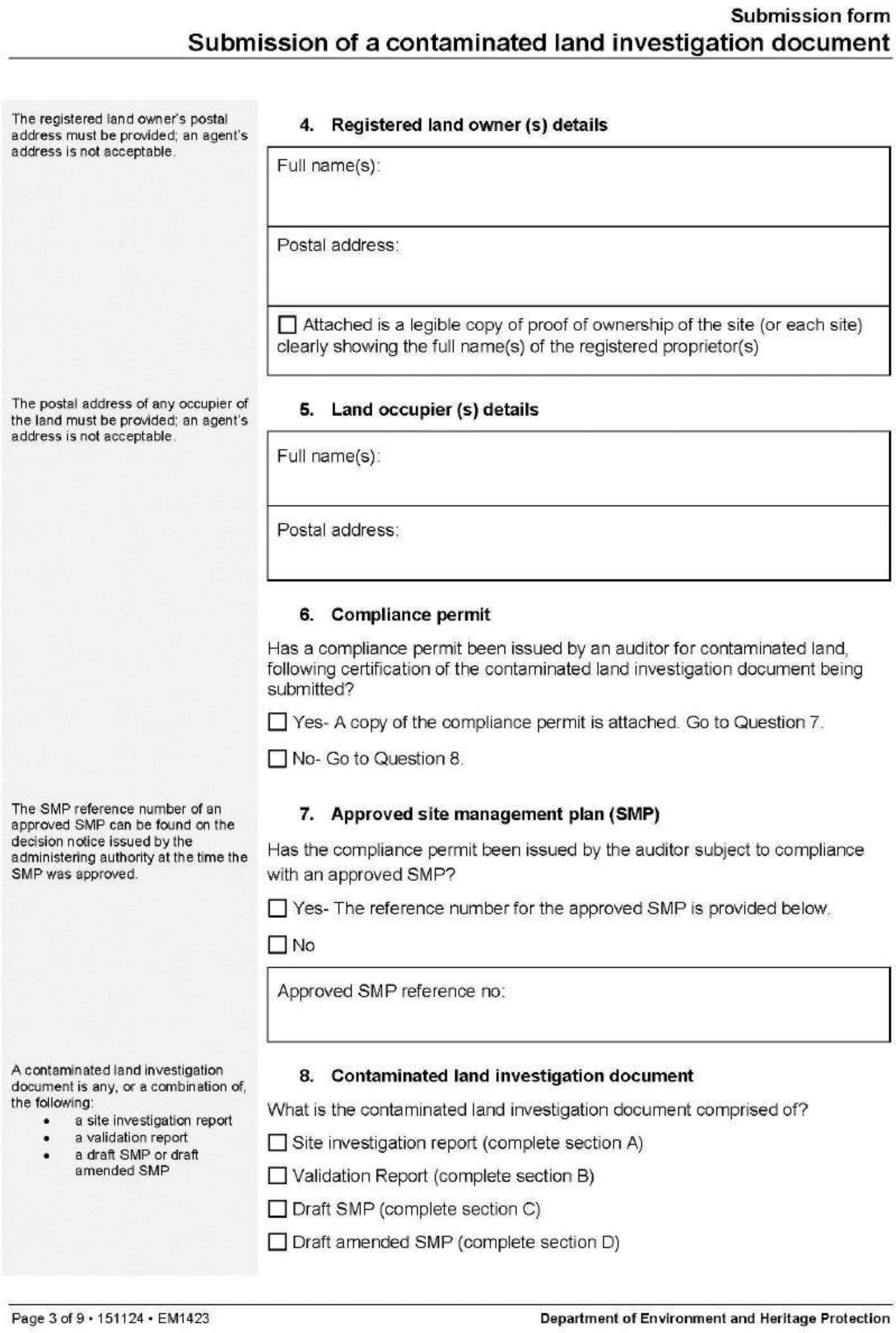
Department of Environment and Heritage Protection



Submission form

Submission of a contaminated land investigation document

The registered land owner's postal address must be provided; an agent's address is not acceptable.

4. Registered land owner (s) details

Full name(s):

Postal address:

☐ Attached is a legible copy of proof of ownership of the site (or each site) clearly showing the full name(s) of the registered proprietor(s)

The postal address of any occupier of the land must be provided; an agent's address is not acceptable.

5. Land occupier (s) details

Full name(s):

Postal address:

6. Compliance permit

Has a compliance permit been issued by an auditor for contaminated land, following certification of the contaminated land investigation document being submitted?

☐ Yes- A copy of the compliance permit is attached. Go to Question 7.

☐ No- Go to Question 8.

The SMP reference number of an approved SMP can be found on the decision notice issued by the administering authority at the time the SMP was approved.

7. Approved site management plan (SMP)

Has the compliance permit been issued by the auditor subject to compliance with an approved SMP?

☐ Yes- The reference number for the approved SMP is provided below.

☐ No

Approved SMP reference no:

A contaminated land investigation document is any, or a combination of, the following:

- a site investigation report
- a validation report
- a draft SMP or draft amended SMP

8. Contaminated land investigation document

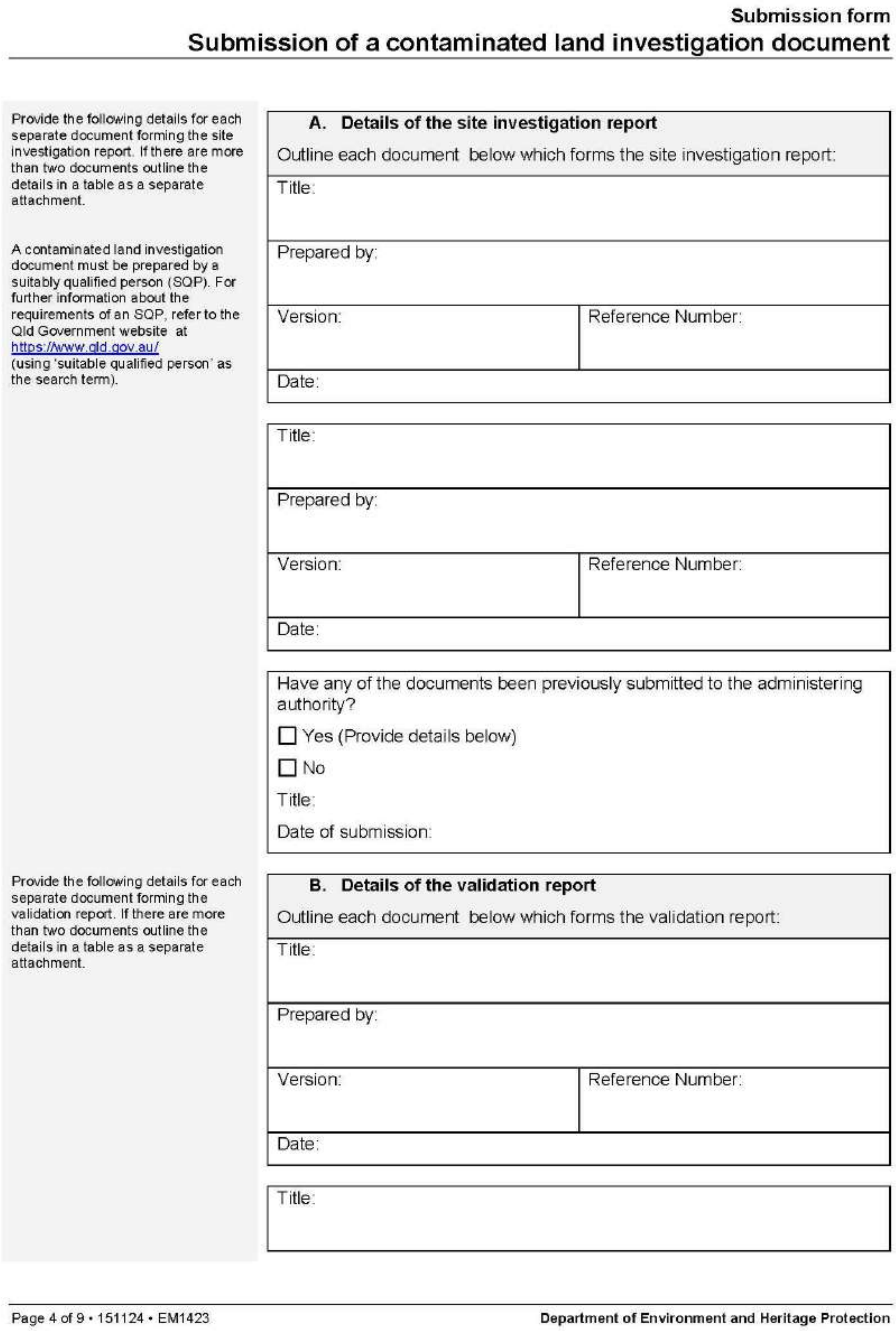
What is the contaminated land investigation document comprised of?

☐ Site investigation report (complete section A)

☐ Validation Report (complete section B)

☐ Draft SMP (complete section C)

☐ Draft amended SMP (complete section D)



Submission form

Submission of a contaminated land investigation document

Provide the following details for each separate document forming the site investigation report. If there are more than two documents outline the details in a table as a separate attachment.

A contaminated land investigation document must be prepared by a suitably qualified person (SQP). For further information about the requirements of an SQP, refer to the Qld Government website at https://www.qld.gov.au/ (using 'suitable qualified person' as the search term).

A. Details of the site investigation report

Outline each document below which forms the site investigation report:

Title:

Prepared by:

Version:

Reference Number:

Date:

Title:

Prepared by:

Version:

Reference Number:

Date:

Have any of the documents been previously submitted to the administering authority?

☐ Yes (Provide details below)

☐ No

Title:

Date of submission:

Provide the following details for each separate document forming the validation report. If there are more than two documents outline the details in a table as a separate attachment.

B. Details of the validation report

Outline each document below which forms the validation report:

Title:

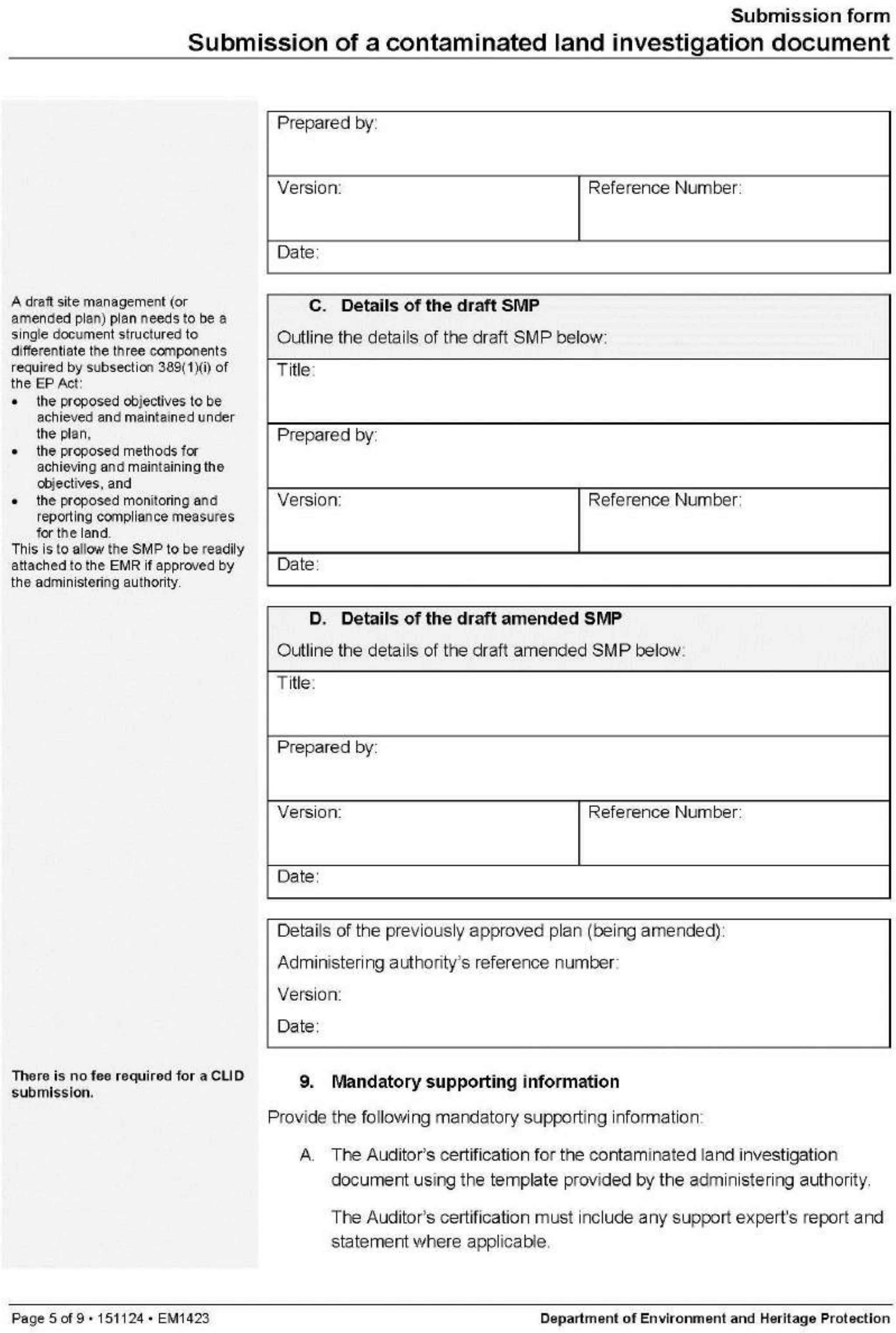
Prepared by:

Version:

Reference Number:

Date:

Title:



Submission form

Submission of a contaminated land investigation document

Prepared by:	
Version:	Reference Number:
Date:	

A draft site management (or amended plan) plan needs to be a single document structured to differentiate the three components required by subsection 389(1)(i) of the EP Act:

- the proposed objectives to be achieved and maintained under the plan,
- the proposed methods for achieving and maintaining the objectives, and
- the proposed monitoring and reporting compliance measures for the land.

This is to allow the SMP to be readily attached to the EMR if approved by the administering authority.

C. Details of the draft SMP Outline the details of the draft SMP below:	
Title:	
Prepared by:	
Version:	Reference Number:
Date:	

D. Details of the draft amended SMP Outline the details of the draft amended SMP below:	
Title:	
Prepared by:	
Version:	Reference Number:
Date:	

Details of the previously approved plan (being amended):

Administering authority's reference number:

Version:

Date:

There is no fee required for a CLID submission.

9. Mandatory supporting information

Provide the following mandatory supporting information:

A. The Auditor's certification for the contaminated land investigation document using the template provided by the administering authority.

The Auditor's certification must include any support expert's report and statement where applicable.

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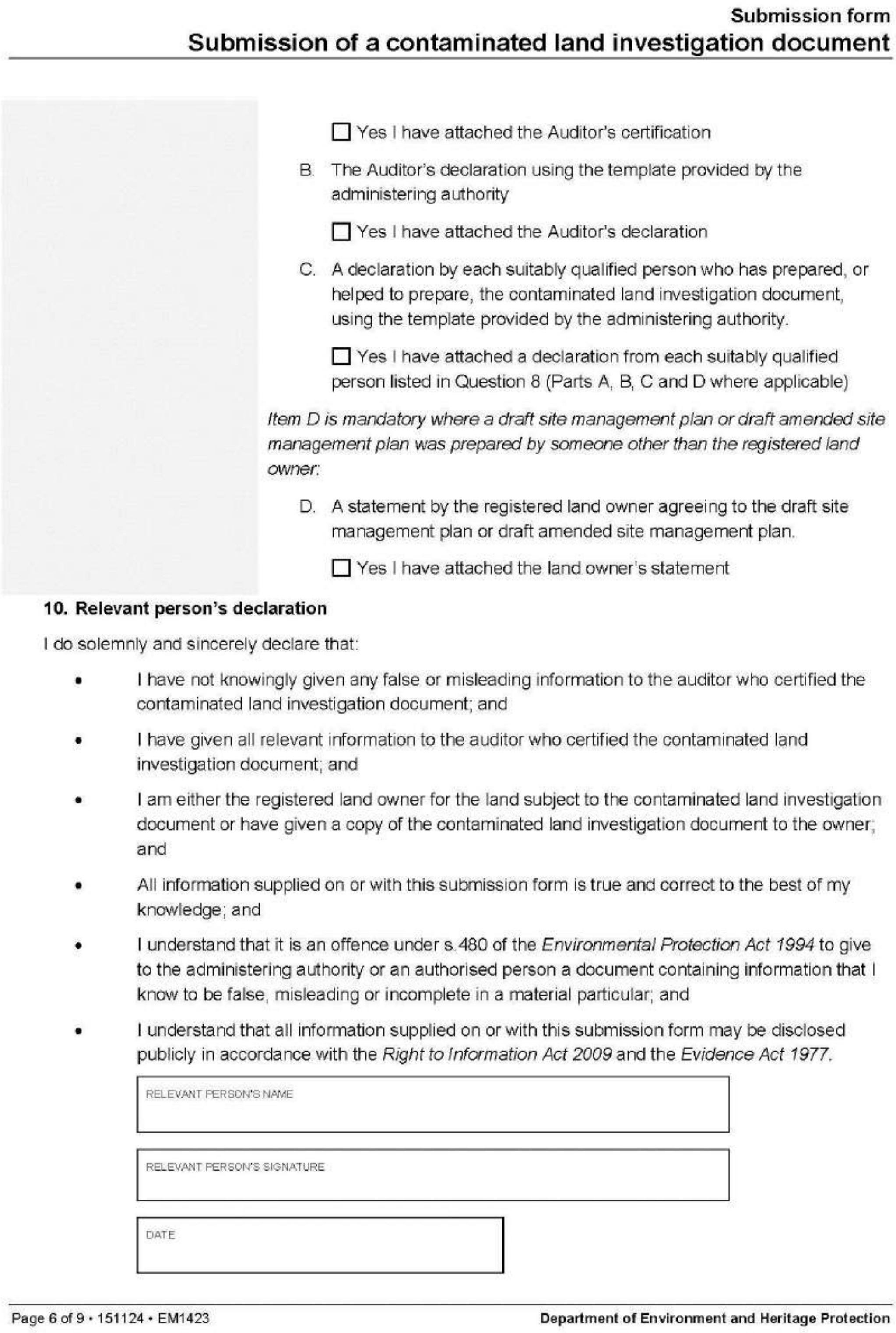
Department of Environment and Heritage Protection



Submission form

Submission of a contaminated land investigation document

☐ Yes I have attached the Auditor's certification

B. The Auditor's declaration using the template provided by the administering authority

☐ Yes I have attached the Auditor's declaration

C. A declaration by each suitably qualified person who has prepared, or helped to prepare, the contaminated land investigation document, using the template provided by the administering authority.

☐ Yes I have attached a declaration from each suitably qualified person listed in Question 8 (Parts A, B, C and D where applicable)

Item D is mandatory where a draft site management plan or draft amended site management plan was prepared by someone other than the registered land owner:

D. A statement by the registered land owner agreeing to the draft site management plan or draft amended site management plan.

☐ Yes I have attached the land owner's statement

10. Relevant person's declaration

I do solemnly and sincerely declare that:

- I have not knowingly given any false or misleading information to the auditor who certified the contaminated land investigation document; and
- I have given all relevant information to the auditor who certified the contaminated land investigation document; and
- I am either the registered land owner for the land subject to the contaminated land investigation document or have given a copy of the contaminated land investigation document to the owner; and
- All information supplied on or with this submission form is true and correct to the best of my knowledge; and
- I understand that it is an offence under s.480 of the *Environmental Protection Act 1994* to give to the administering authority or an authorised person a document containing information that I know to be false, misleading or incomplete in a material particular; and
- I understand that all information supplied on or with this submission form may be disclosed publicly in accordance with the *Right to Information Act 2009* and the *Evidence Act 1977*.

RELEVANT PERSON'S NAME

RELEVANT PERSON'S SIGNATURE

DATE

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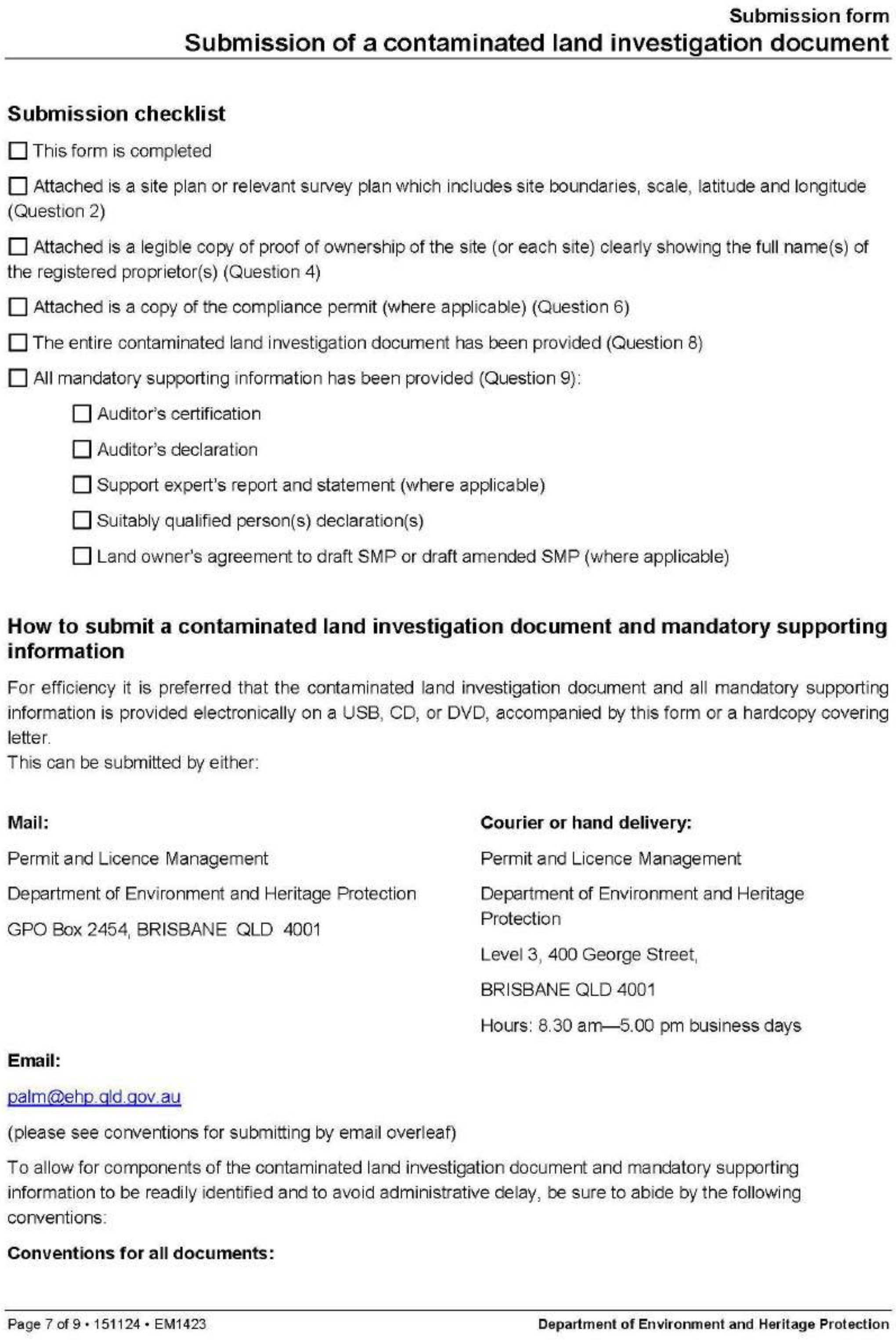
Department of Environment and Heritage Protection



Submission form

Submission of a contaminated land investigation document

Submission checklist

☐ This form is completed

☐ Attached is a site plan or relevant survey plan which includes site boundaries, scale, latitude and longitude (Question 2)

☐ Attached is a legible copy of proof of ownership of the site (or each site) clearly showing the full name(s) of the registered proprietor(s) (Question 4)

☐ Attached is a copy of the compliance permit (where applicable) (Question 6)

☐ The entire contaminated land investigation document has been provided (Question 8)

☐ All mandatory supporting information has been provided (Question 9):

- ☐ Auditor's certification
- ☐ Auditor's declaration
- ☐ Support expert's report and statement (where applicable)
- ☐ Suitably qualified person(s) declaration(s)
- ☐ Land owner's agreement to draft SMP or draft amended SMP (where applicable)

How to submit a contaminated land investigation document and mandatory supporting information

For efficiency it is preferred that the contaminated land investigation document and all mandatory supporting information is provided electronically on a USB, CD, or DVD, accompanied by this form or a hardcopy covering letter.
This can be submitted by either:

Mail:

Permit and Licence Management

Department of Environment and Heritage Protection

GPO Box 2454, BRISBANE QLD 4001

Courier or hand delivery:

Permit and Licence Management

Department of Environment and Heritage Protection

Level 3, 400 George Street,

BRISBANE QLD 4001

Hours: 8.30 am—5.00 pm business days

Email:

palm@ehp.qld.gov.au

(please see conventions for submitting by email overleaf)

To allow for components of the contaminated land investigation document and mandatory supporting information to be readily identified and to avoid administrative delay, be sure to abide by the following conventions:

Conventions for all documents:

Submission form

Submission of a contaminated land investigation document

- documents are to given a unique title or name, incorporating their date of completion (in dd_mm_yyyy format)
- pages in each document are to be numbered consecutively
- the page size is to be set to the ISO A-series standard
- the resolution of PDF file should not be lower than 300 dots per inch
- where practicable, any attachments, such as photos, figures or maps, are to be included as part of the primary document
- colour and black and white information should be able to be appropriately reproduced.

Convention for site management plans (including amended site management plans)

A draft site management plan needs to be a single document. It needs to be structured to differentiate the three components required by subsection 389(1)(i):

- the proposed objectives to be achieved and maintained under the plan
- the proposed methods for achieving and maintaining the objectives
- the proposed monitoring and reporting compliance measures for the land.

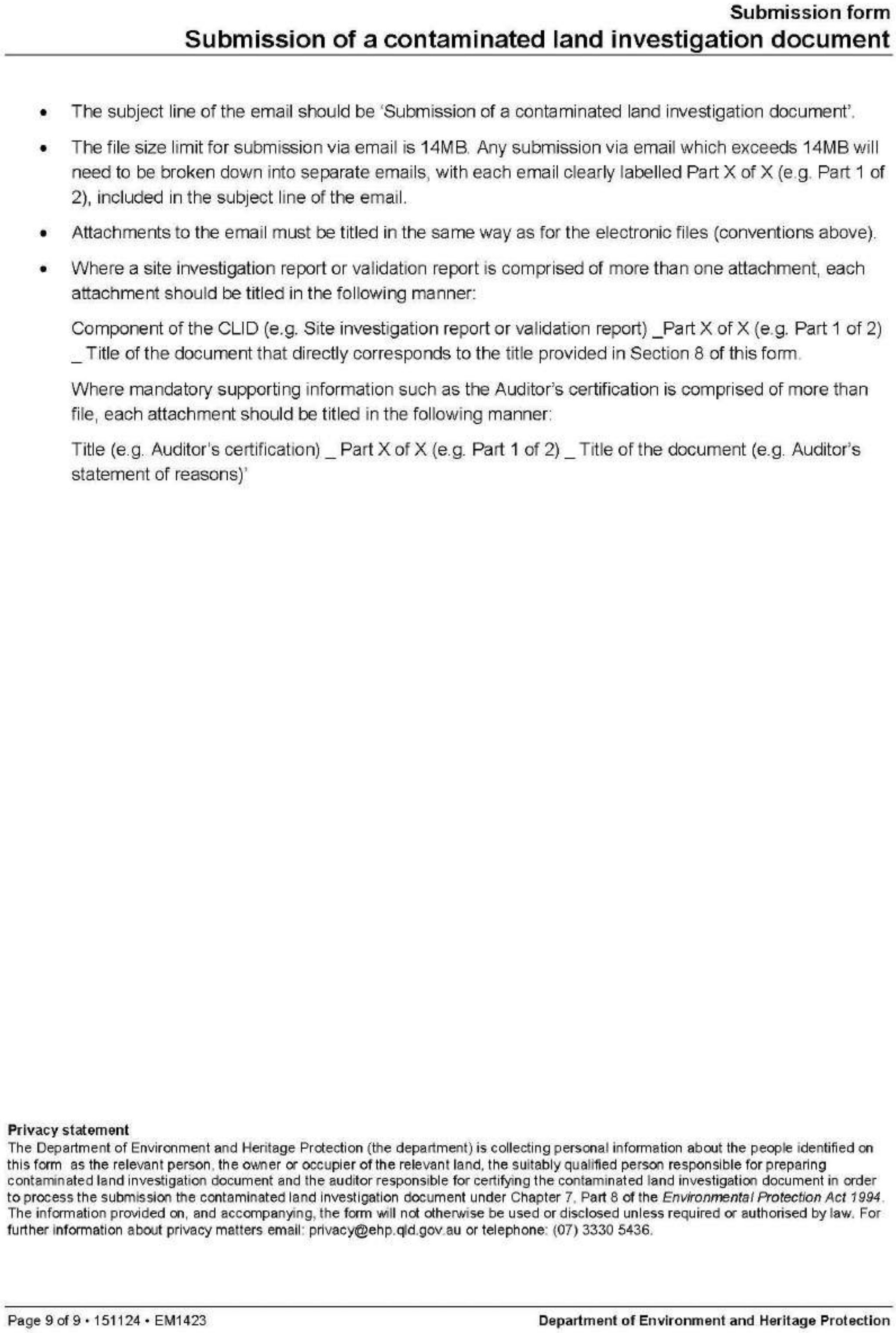
This is to allow the SMP to be readily attached to the EMR if approved.

Conventions for electronic files

- A site investigation report or validation report and the mandatory supporting information should be provided as one or more electronic documents in a searchable PDF file (i.e. portable document format).
- Where a site investigation report or validation report is composed of one document, the title of the PDF file should be 'Site investigation report' or 'Validation report'. Where the report is comprised of a number of separate documents, each PDF file should be placed in an electronic folder named 'Site investigation report' or 'Validation report', with each PDF file given a title that directly corresponds to the title provided for the document in Section 8 of this form.
- A draft site management plan or draft amended draft site management plan should be provided as one Microsoft Word document file and should be given a title that directly corresponds to the title provided in Section 8 of this form.
- Mandatory supporting information should be separate PDF files titled:
    - Suitably qualified person's declaration(s)
    - Auditor's certification
    - Auditor's declaration
    - Compliance permit
    - Landowner agreement to draft site management plan

  Where any of these are comprised of more than one document a folder should be created and titled as per the above with each PDF file in the folder given the same title as the individual PDF document.
- PDF and Microsoft Word files should not be encrypted or require password access or be dependent on external attachments for legibility.

Conventions for submission via email:



Submission form

Submission of a contaminated land investigation document

- The subject line of the email should be 'Submission of a contaminated land investigation document'.
- The file size limit for submission via email is 14MB. Any submission via email which exceeds 14MB will need to be broken down into separate emails, with each email clearly labelled Part X of X (e.g. Part 1 of 2), included in the subject line of the email.
- Attachments to the email must be titled in the same way as for the electronic files (conventions above).
- Where a site investigation report or validation report is comprised of more than one attachment, each attachment should be titled in the following manner:

  Component of the CLID (e.g. Site investigation report or validation report) _Part X of X (e.g. Part 1 of 2) _ Title of the document that directly corresponds to the title provided in Section 8 of this form.

  Where mandatory supporting information such as the Auditor's certification is comprised of more than file, each attachment should be titled in the following manner:

  Title (e.g. Auditor's certification) _ Part X of X (e.g. Part 1 of 2) _ Title of the document (e.g. Auditor's statement of reasons)'

Privacy statement
The Department of Environment and Heritage Protection (the department) is collecting personal information about the people identified on this form as the relevant person, the owner or occupier of the relevant land, the suitably qualified person responsible for preparing contaminated land investigation document and the auditor responsible for certifying the contaminated land investigation document in order to process the submission the contaminated land investigation document under Chapter 7, Part 8 of the *Environmental Protection Act 1994*. The information provided on, and accompanying, the form will not otherwise be used or disclosed unless required or authorised by law. For further information about privacy matters email: privacy@ehp.qld.gov.au or telephone: (07) 3330 5436.

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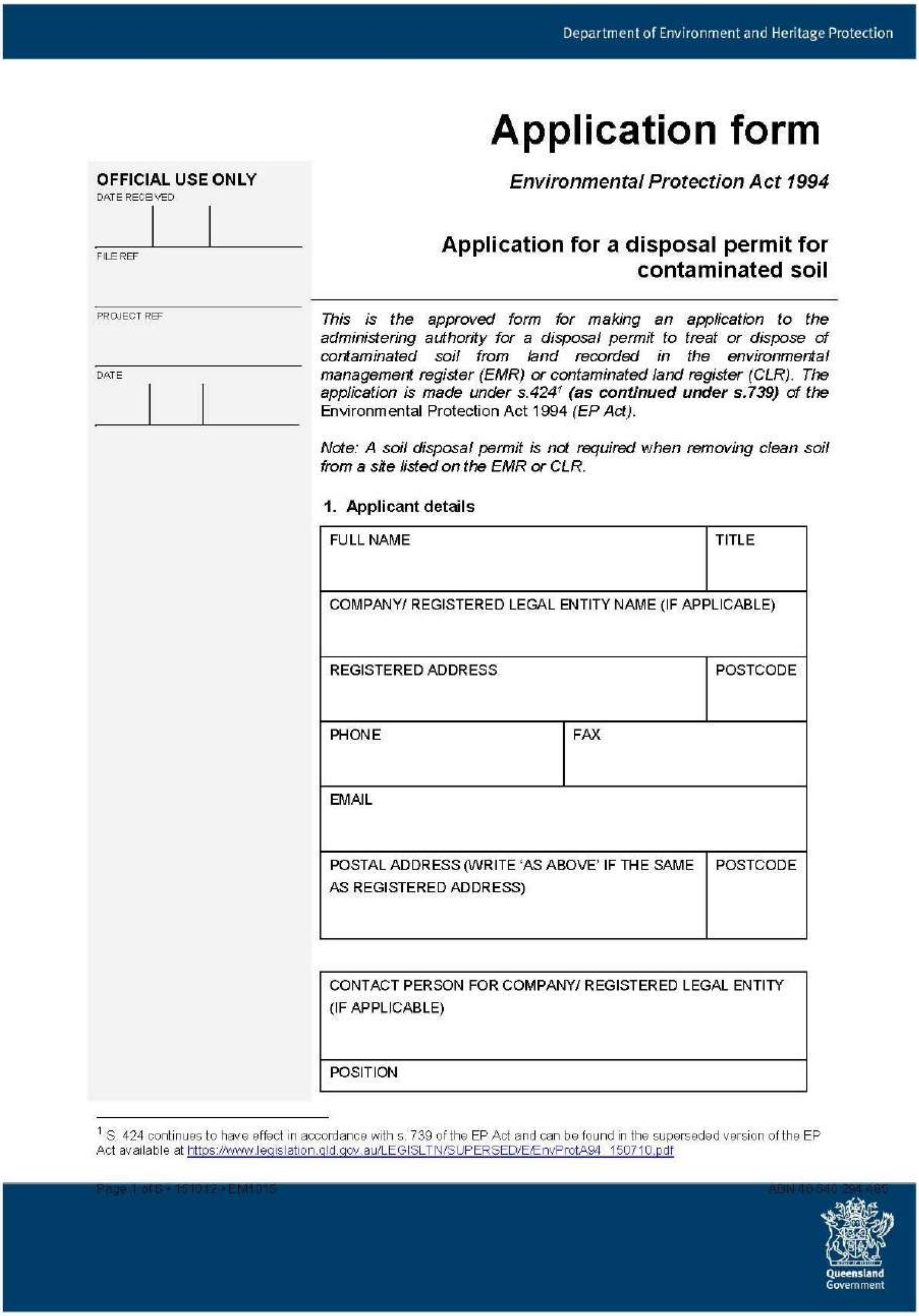

Department of Environment and Heritage Protection

Application form

Environmental Protection Act 1994

Application for a disposal permit for contaminated soil

OFFICIAL USE ONLY

DATE RECEIVED

FILE REF

PROJECT REF

DATE

This is the approved form for making an application to the administering authority for a disposal permit to treat or dispose of contaminated soil from land recorded in the environmental management register (EMR) or contaminated land register (CLR). The application is made under s.424[1] ***(as continued under s.739)*** *of the* Environmental Protection Act 1994 *(EP Act).*

Note: A soil disposal permit is not required when removing clean soil from a site listed on the EMR or CLR.

1. Applicant details

FULL NAME	TITLE
COMPANY/ REGISTERED LEGAL ENTITY NAME (IF APPLICABLE)	
REGISTERED ADDRESS	POSTCODE
PHONE	FAX
EMAIL	
POSTAL ADDRESS (WRITE 'AS ABOVE' IF THE SAME AS REGISTERED ADDRESS)	POSTCODE

CONTACT PERSON FOR COMPANY/ REGISTERED LEGAL ENTITY (IF APPLICABLE)
POSITION

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[1] S. 424 continues to have effect in accordance with s. 739 of the EP Act and can be found in the superseded version of the EP Act available at https://www.legislation.qld.gov.au/LEGISLTN/SUPERSED/E/EnvProtA94_150710.pdf

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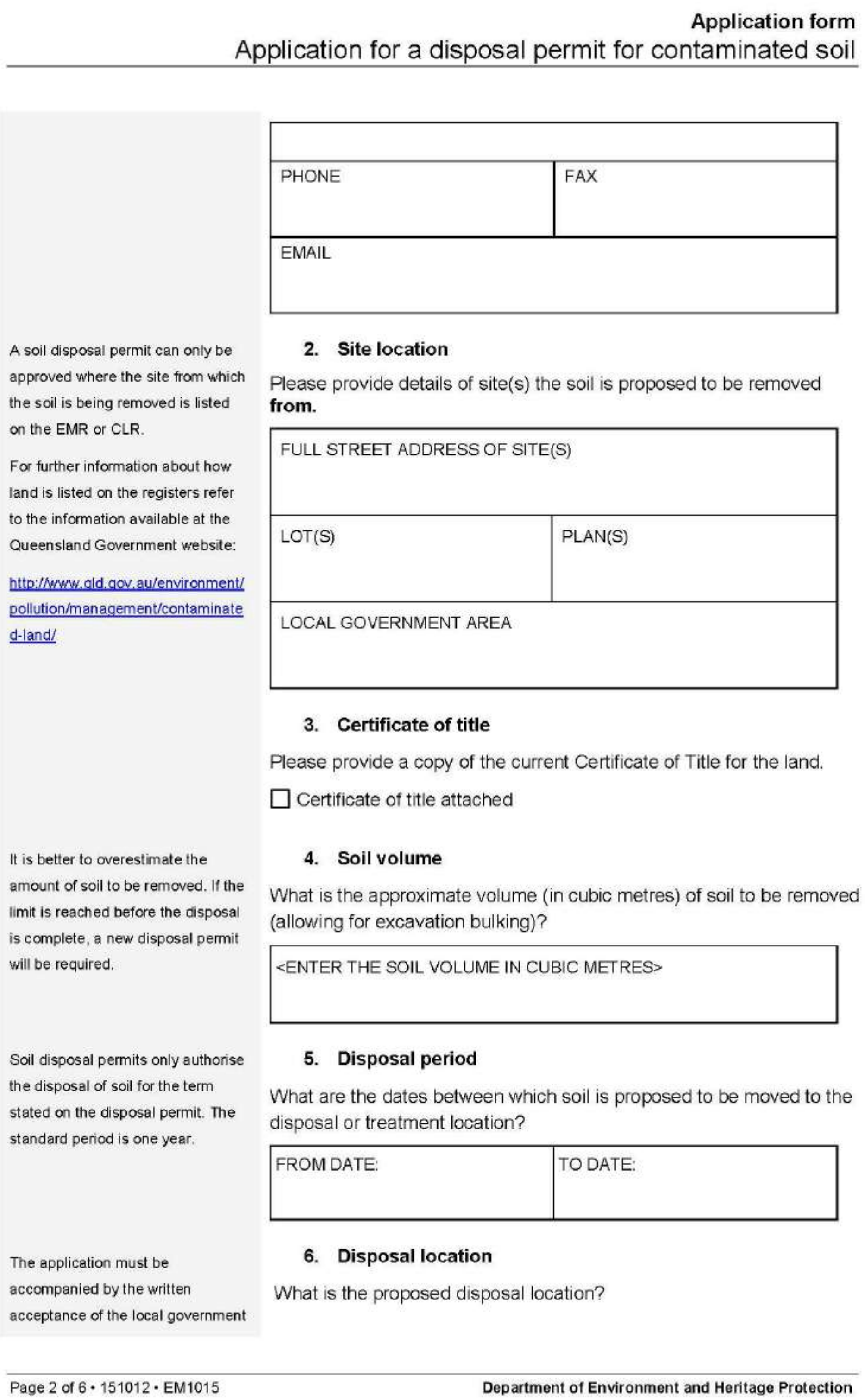
ABN 46 640 294 485

Queensland Government



Application form

Application for a disposal permit for contaminated soil

PHONE	FAX
EMAIL	

A soil disposal permit can only be approved where the site from which the soil is being removed is listed on the EMR or CLR.

For further information about how land is listed on the registers refer to the information available at the Queensland Government website:

http://www.qld.gov.au/environment/pollution/management/contaminated-land/

2. Site location

Please provide details of site(s) the soil is proposed to be removed **from.**

FULL STREET ADDRESS OF SITE(S)	
LOT(S)	PLAN(S)
LOCAL GOVERNMENT AREA	

3. Certificate of title

Please provide a copy of the current Certificate of Title for the land.

☐ Certificate of title attached

It is better to overestimate the amount of soil to be removed. If the limit is reached before the disposal is complete, a new disposal permit will be required.

4. Soil volume

What is the approximate volume (in cubic metres) of soil to be removed (allowing for excavation bulking)?

<ENTER THE SOIL VOLUME IN CUBIC METRES>

Soil disposal permits only authorise the disposal of soil for the term stated on the disposal permit. The standard period is one year.

5. Disposal period

What are the dates between which soil is proposed to be moved to the disposal or treatment location?

FROM DATE:	TO DATE:

The application must be accompanied by the written acceptance of the local government

6. Disposal location

What is the proposed disposal location?

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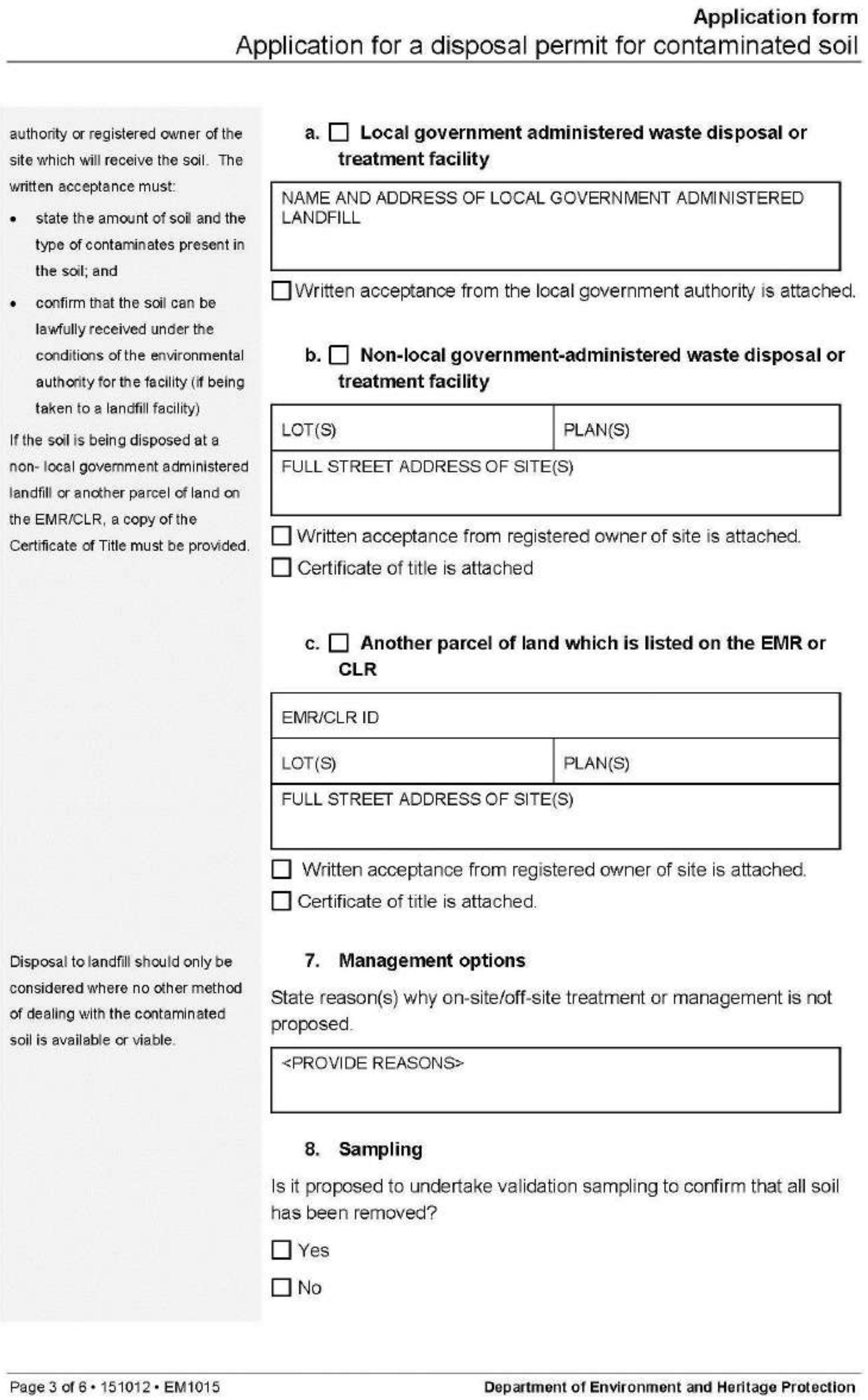

Application form

Application for a disposal permit for contaminated soil

authority or registered owner of the site which will receive the soil. The written acceptance must:

- state the amount of soil and the type of contaminates present in the soil; and
- confirm that the soil can be lawfully received under the conditions of the environmental authority for the facility (if being taken to a landfill facility)

If the soil is being disposed at a non- local government administered landfill or another parcel of land on the EMR/CLR, a copy of the Certificate of Title must be provided.

a. ☐ Local government administered waste disposal or treatment facility

NAME AND ADDRESS OF LOCAL GOVERNMENT ADMINISTERED LANDFILL

☐ Written acceptance from the local government authority is attached.

b. ☐ Non-local government-administered waste disposal or treatment facility

LOT(S)	PLAN(S)
FULL STREET ADDRESS OF SITE(S)	

☐ Written acceptance from registered owner of site is attached.

☐ Certificate of title is attached

c. ☐ Another parcel of land which is listed on the EMR or CLR

EMR/CLR ID	
LOT(S)	PLAN(S)
FULL STREET ADDRESS OF SITE(S)	

☐ Written acceptance from registered owner of site is attached.

☐ Certificate of title is attached.

Disposal to landfill should only be considered where no other method of dealing with the contaminated soil is available or viable.

7. Management options

State reason(s) why on-site/off-site treatment or management is not proposed.

<PROVIDE REASONS>

8. Sampling

Is it proposed to undertake validation sampling to confirm that all soil has been removed?

☐ Yes

☐ No

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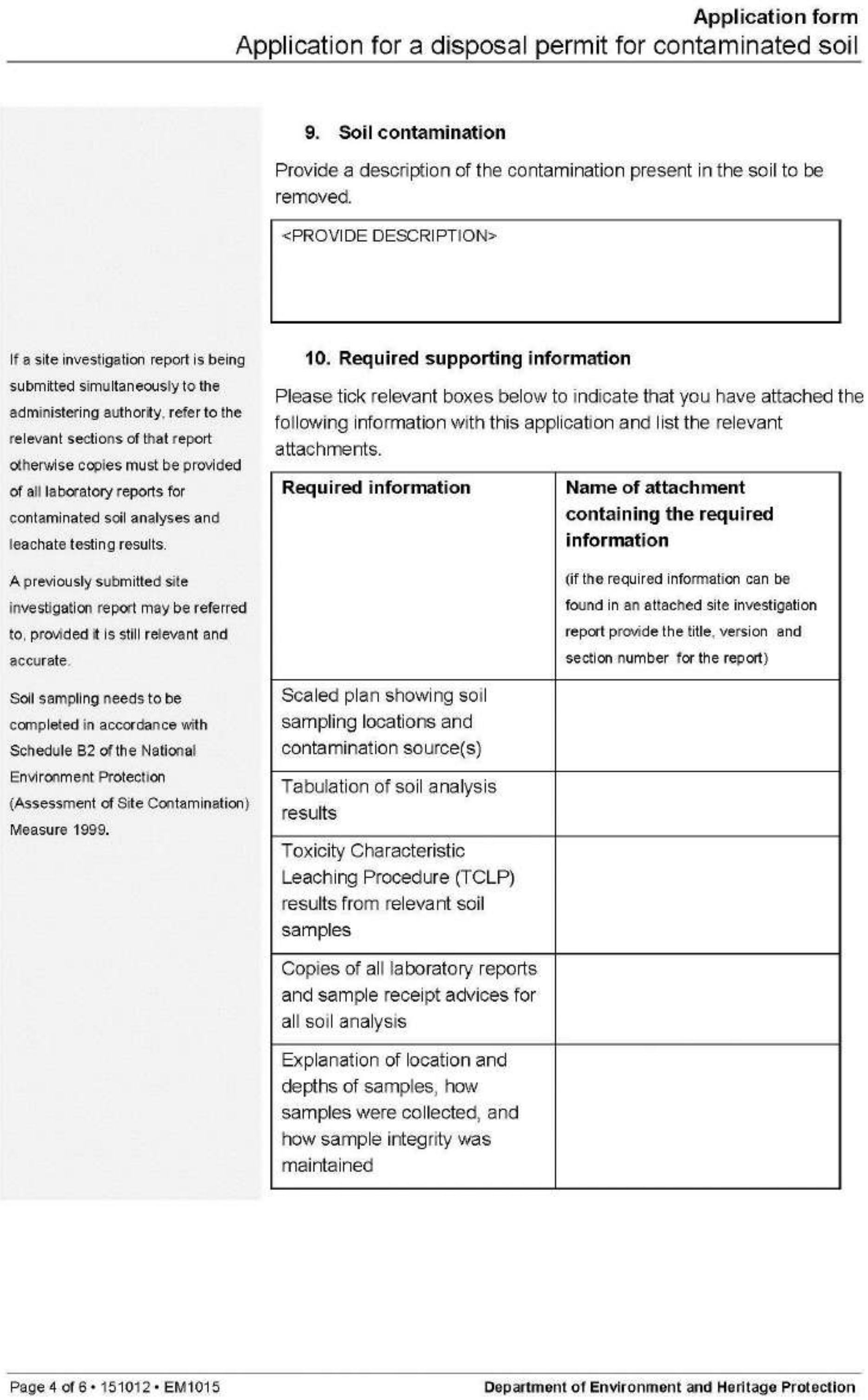
Department of Environment and Heritage Protection



Application form

Application for a disposal permit for contaminated soil

9. Soil contamination

Provide a description of the contamination present in the soil to be removed.

<PROVIDE DESCRIPTION>

10. Required supporting information

Please tick relevant boxes below to indicate that you have attached the following information with this application and list the relevant attachments.

Required information	Name of attachment containing the required information (if the required information can be found in an attached site investigation report provide the title, version and section number for the report)
Scaled plan showing soil sampling locations and contamination source(s)	
Tabulation of soil analysis results	
Toxicity Characteristic Leaching Procedure (TCLP) results from relevant soil samples	
Copies of all laboratory reports and sample receipt advices for all soil analysis	
Explanation of location and depths of samples, how samples were collected, and how sample integrity was maintained	

If a site investigation report is being submitted simultaneously to the administering authority, refer to the relevant sections of that report otherwise copies must be provided of all laboratory reports for contaminated soil analyses and leachate testing results.

A previously submitted site investigation report may be referred to, provided it is still relevant and accurate.

Soil sampling needs to be completed in accordance with Schedule B2 of the National Environment Protection (Assessment of Site Contamination) Measure 1999.

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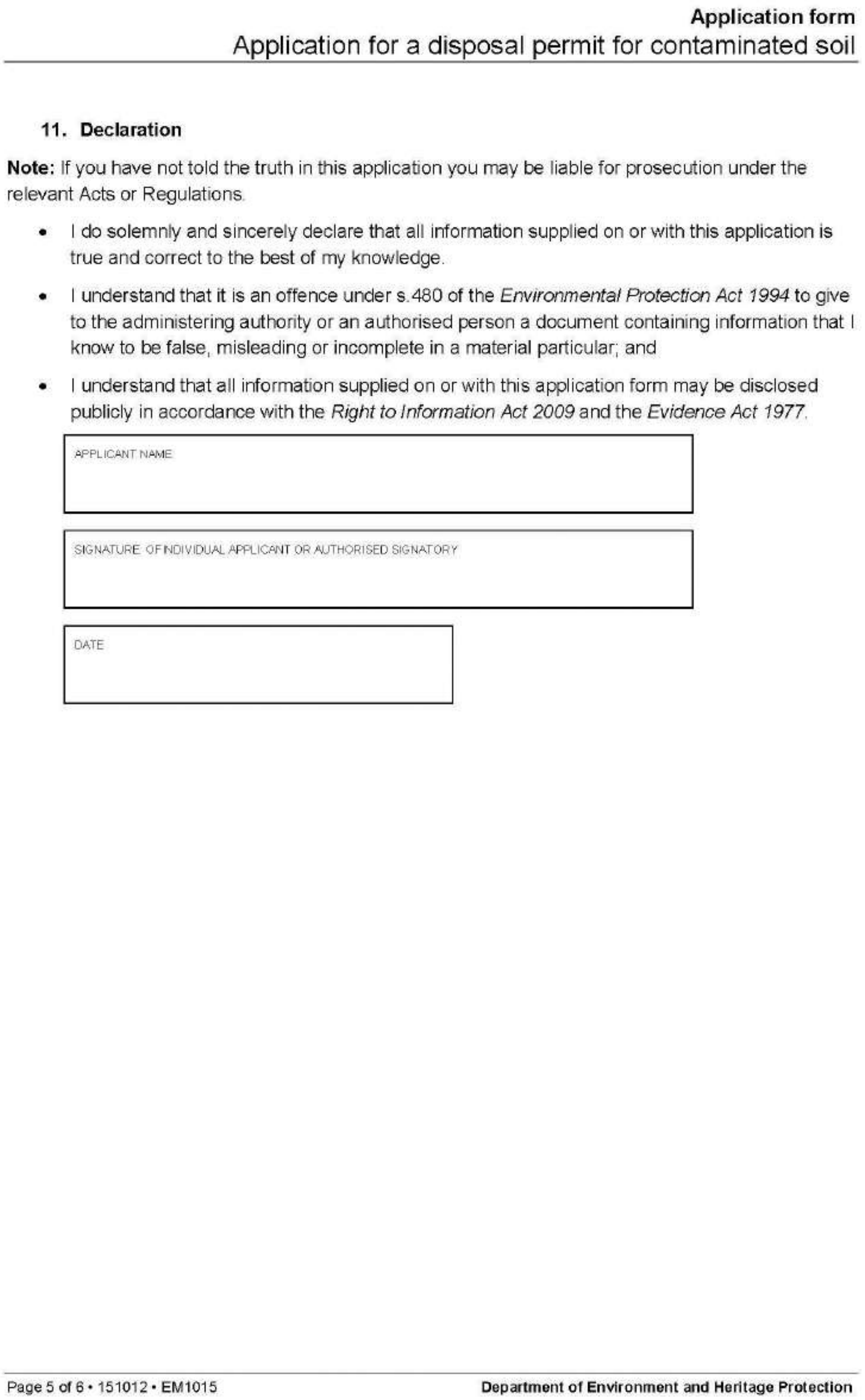
Department of Environment and Heritage Protection



Application form

Application for a disposal permit for contaminated soil

11. Declaration

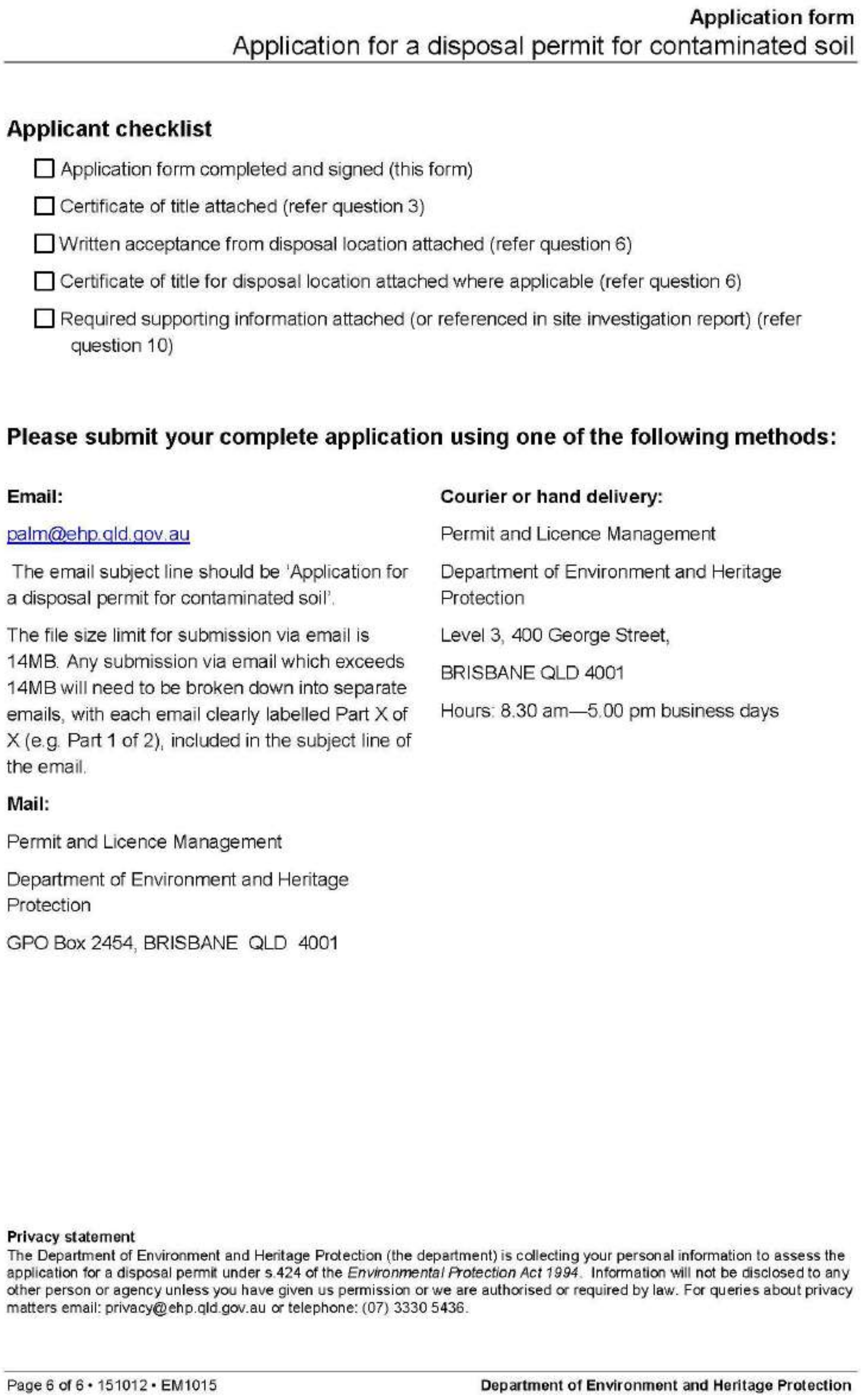
Note: If you have not told the truth in this application you may be liable for prosecution under the relevant Acts or Regulations.

- I do solemnly and sincerely declare that all information supplied on or with this application is true and correct to the best of my knowledge.
- I understand that it is an offence under s.480 of the *Environmental Protection Act 1994* to give to the administering authority or an authorised person a document containing information that I know to be false, misleading or incomplete in a material particular; and
- I understand that all information supplied on or with this application form may be disclosed publicly in accordance with the *Right to Information Act 2009* and the *Evidence Act 1977*.

APPLICANT NAME

SIGNATURE OF INDIVIDUAL APPLICANT OR AUTHORISED SIGNATORY

DATE



Application form

Application for a disposal permit for contaminated soil

Applicant checklist

- ☐ Application form completed and signed (this form)
- ☐ Certificate of title attached (refer question 3)
- ☐ Written acceptance from disposal location attached (refer question 6)
- ☐ Certificate of title for disposal location attached where applicable (refer question 6)
- ☐ Required supporting information attached (or referenced in site investigation report) (refer question 10)

Please submit your complete application using one of the following methods:

Email:

palm@ehp.qld.gov.au

The email subject line should be 'Application for a disposal permit for contaminated soil'.

The file size limit for submission via email is 14MB. Any submission via email which exceeds 14MB will need to be broken down into separate emails, with each email clearly labelled Part X of X (e.g. Part 1 of 2), included in the subject line of the email.

Mail:

Permit and Licence Management

Department of Environment and Heritage Protection

GPO Box 2454, BRISBANE QLD 4001

Courier or hand delivery:

Permit and Licence Management

Department of Environment and Heritage Protection

Level 3, 400 George Street,

BRISBANE QLD 4001

Hours: 8.30 am—5.00 pm business days

Privacy statement

The Department of Environment and Heritage Protection (the department) is collecting your personal information to assess the application for a disposal permit under s.424 of the *Environmental Protection Act 1994*. Information will not be disclosed to any other person or agency unless you have given us permission or we are authorised or required by law. For queries about privacy matters email: privacy@ehp.qld.gov.au or telephone: (07) 3330 5436.

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Document Change History

Doc. No.	Rev. No.	Rev. Date	Revision Description	Page No.	Approved by
EAD-EQ-PR-UG-01	01	January 2018	Second Issue	7, 10, 15, 42, 72, 73, 74	Secretary General
Remarks:					

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