SOHAR PORT / FREEZONE

SIPC & SFZ GUIDELINE FOR ENVIRONMENTAL SOIL SURVEYS

Version 3

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1 Introduction

Sohar Industrial Port Company (SIPC) and SOHAR Freezone LLC (SFZ) has specific standards in place for zero and end surveys for soil quality when leasing out or leasing back plots. This guideline describes the specific technical requirements when carrying out zero and end soil surveys. The guideline is primarily meant for the contractor that carries out the survey.

The zero survey is used to describe the initial soil quality at the beginning of a tenant's lease period and is a reference to the quality when the plot is leased back. The end survey is used to describe the soil quality after a tenant's lease period.

If the end survey indicates new or increased contamination of soil (ground or groundwater) the tenant shall propose and carry out a mutually agreed plan to remediate the contamination as per the state in the zero survey.

Contractors who carry out soil surveys for SIPC / SFZ or its tenants must carry out and report the survey, according to this guideline. All soil surveys carried out within the Port and Freezone area have to comply with Omani laws and regulations.

Zero/end soil surveys must be carried out by a contractor with valid registration from the Environment Authority (EA). The remediation activities have to be done under the supervision of the EA registered contractor.

1.1 Objective of Zero and End Surveys

The zero survey aims to capture and describe the environmental soil quality at the time of leasing out a plot to a tenant. The report made by zero measurements is part of the sub usufruct contract. The report has to give a very clear description of the soil quality at the beginning of the lease period to SIPC / SFZ and the tenant.

The end survey aims to capture the environmental soil quality after a tenant's lease period. The soil quality has to be compared with the zero measurements. If upon comparison, any additional contamination is found, the end measurement has to quantify the extent of this contamination horizontally and vertically in-ground and groundwater. The quantification has to be done to an accuracy level sufficient to make up a detailed cost calculation for the remediation and to carry out the remediation.

1.2 Instructing Party

During a zero survey, the tenant is the instructing party. During an end survey, SIPC / SFZ is the instructing party. Both the zero and end surveys are paid for by the tenant.

2 Process

Any soil survey consists of the following activities:

1. Preliminary desk research
2. Defining a research strategy
3. Fieldwork
4. Analysis of soil samples
5. Reporting

The different activities are described in sections 2-7 within this guideline.

2.1 Method Statement

After the preliminary desk research and determination of the research strategy, the contractor shall write a method statement for the soil survey. This method statement shall be approved by SIPC / SFZ before the survey can be carried out. The method statement must contain:

1. A description of desk research
2. A sampling and analysis plan
3. A map of the location with potential former/current/future sources of pollution and the proposed borehole locations
4. Procedures for sampling, decontamination, storage, transportation, site protection and Health and Safety issues relevant to the individual project
5. A proposed laboratory
6. A proposed testing suites
7. Deviation of this guideline (if any)

The deviation of this guideline is only allowed after a written request for permission and authorisation by (SIPC / SFZ). Every deviation needs a source of motivation, from the consequences of the deviation to the reliability of the results of the survey. SIPC / SFZ reserves the right to decline the survey if this condition is not met.

2.2 Report

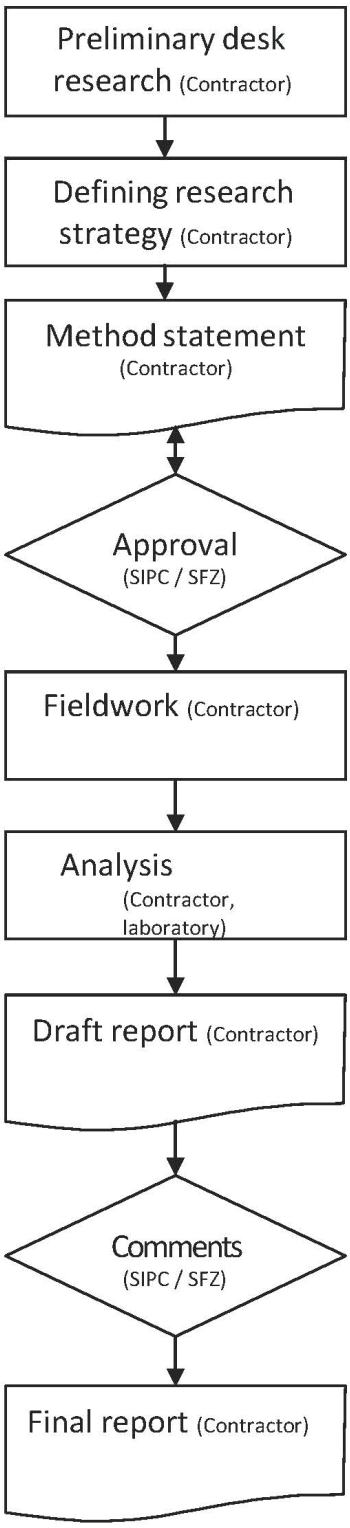
The report of the zero or end survey shall be presented in a draft to (SIPC / SFZ). The draft report shall be revised based on the comments provided thereafter.

SIPC / SFZ reserves the right to decline the report if this condition is not met or if the report does not comply with this guideline.

2.3 Flow Chart

The process of any soil survey is described in a flow chart (Figure 1).

Figure 1: Flow Chart



3 Preliminary Desk Research

To define the right research strategy for a zero or end survey, desk research should be carried out first. This preliminary desk research is described in this section.

The outcome of the desk research shall be reported in the method statement and the final report.

3.1 Site Inspection

The site has to be visually inspected. During this inspection special attention is needed for potential sources of pollution.

At a site which has never been in use for industrial purposes, attention is needed for at least the following potential sources of pollution (not limited to):

- Waste dumps
- Asbestos
- Possible point sources of pollution near the site boundaries
- Visible signs of contamination on the surface
- Land cuts and fills

At a site which has been used for industrial purposes, attention is needed for the following possible present or former sources of pollution (not limited to):

- Waste dumps
- Asbestos
- Possible point sources of pollution near the site boundaries
- Visible signs of contamination on the surface
- Land cuts and fills
- Tanks (above ground and underground)
- Fill and venting points of tanks
- Petrol pump/filling station
- Pipelines
- Oil-water separators
- Chemical process installations
- Storage of barrels/chemicals
- Feedstock/waste/product storage yards
- Workshops
- Etc.

Besides potential sources of pollution, foundations and pavements (restings) have to be included in the site inspection. Pavements can be considered as, more or less, soil protecting measures that prevent contamination of the soil below. For this, it is important to know whether an activity took place on a paved surface.

All the observed potential sources of soil pollution foundations and pavements (restings) have to be drawn accurately on a map. On this map, the present constructions have to also be included.

During the site inspections, digital pictures have to be taken from an overhead view and relevant observations.

3.2 Archive Research

For the archive research, the following entities should be consulted for any request of information:

- SIPC / SFZ Environmental Department and Asset Management Department
- Environment Authority (EA)
- Former / current / future tenant

Archive research aims to receive all available relevant information on former and future activities on the plot which could have lead or can lead to contamination of the soil. The information always has to be on a level sufficiently detailed to define the right research strategy later on. It is obvious that for zero measurements on a plot that has never been used, the inquiry effort will be lower than that for an end measurement of a plot with a history of industrial use.

SIPC / SFZ will give information about the lease out history of the plot. EA has information about the activities which took place on the plot based on the permits. They might also have information about incidents (e.g. spills) which might have caused soil pollution. Employees of the current/future tenant can give insight into the former/ future use of the plot and the kind of soil-threatening sources or products which have been used or will be used.

Different sources have to be asked whether soil reports of earlier surveys are available. If available, the results of these surveys have to be interpreted, in addition to drawing of the site design. Relevant air photos (e.g. Google Earth) of different years have to be included in the archive research.

All relevant information from the archive research has to be drawn exactly on a map. The map contains at least all former, current and future possible sources of soil pollution. On this map, the present constructions have to be included.

3.3 Geology & Hydrology

The general geology and hydrology of (the area around) the research site have to be described. An estimation of the groundwater level and flow pattern has to be made as well.

3.4 Underground infrastructure

Information shall be gathered on underground infrastructure like pipelines and cables within and near the research site. The Asset Management Department of SIPC /SFZ can give information on pipelines and cables in public corridors. The tenant can give information on pipelines and cables within the plot. The drilling plan has to be designed in a way that damage to pipelines and cables or any other underground infrastructure is prevented. In every situation, the contractor of the survey is liable for any damage to pipelines or cables.

4 Research Strategy

The research strategy shall be defined in a manner so that the (zero or end) quality of the soil quality will be determined. Different strategies are distinguished as follows:

1. Unsuspected for pollution: low sampling intensity
2. Unsuspected for pollution: high sampling intensity
3. Potential point sources
4. Further research on pollution encountered

The research strategy for a plot will consist of a combination of one or more of the above- mentioned strategies.

If a recent (< 5 years) soil survey is available and the historical survey made clear that no pollution is to be expected, then the sampling/drilling intensity might be lowered.

The proposed research strategy shall be included in the method statement. The proposed locations for the boreholes shall also be included in the map.

4.1 Unsuspected for Pollution: Low Sampling Intensity

This strategy can be applied during zero measurements when the preliminary desk research made clear that:

- The site was never in use for industrial purposes ("Greenfield")
- No pollution is to be expected

Table 1: Quantity of boreholes and samples to be analysed on a plot unsuspected for pollution with low sampling intensity

Area plot (ha)	**Quantity boreholes**			**Quantity of samples to be analysed**		
	Borehole to 0,5 m	Borehole to 2,0 m	Borehole to groundwater with a standpipe	Surface layer (0,0-0,5 m)	Deeper layers	groundwater
1	7	3	1	2	1	1
2	11	4	2	2	2	2
3	14	5	2	3	2	2
4	18	6	2	3	2	2
5	21	7	2	4	2	2
10	39	12	4	6	4	4
20	74	22	6	11	6	6
P	**3.5 + 3.5p**	**2.0 + 1P**	**1 + 0.25P**	**1 + 0.5P**	**1+0.25P**	**1+0.25P**

– Boreholes have to be placed at random on the site;
– If the groundwater is below 10 m of the surface, the number of standpipes might be reduced;
– If during fieldwork contamination is suspected (sensory observation) the analysis strategy has to be intensified.

4.2 Unsuspected for Pollution: High Sampling Intensity

This strategy can be applied during zero or end measurements when the preliminary desk research made clear that:

- The site has been in use for industrial purposes
- No pollution is to be expected

Table 2: Quantity of boreholes and samples to be analysed on a plot unsuspected for pollution with high sampling intensity

Area plot (ha)	**Quantity boreholes**			**Quantity of samples to be analysed**		
	Borehole to 0,5 m	Borehole to 2,0 m	Borehole to groundwater with a standpipe	Surface layer (0,0-0,5 m)	Deeper layers	groundwater
1	9	4	2	2	2	2
2	14	5	2	3	2	2
3	19	7	3	4	3	3
4	24	8	3	5	3	3
5	29	10	4	6	4	4
10	54	17	6	11	6	6
20	104	32	11	21	11	11
P	**3.5 + 5P**	**2.0 + 1.5P**	**1 + 0.5P**	**1 + 1P**	**1+0.5P**	**1+0.5P**

– Boreholes have to be placed at random on the site;
– If the groundwater is below 10 m of surface, the number of standpipes might be reduced;
– If during fieldwork contamination is suspected (sensory observation) the analysis strategy has to be intensified.

4.3 Potential Point Sources

This strategy must be applied during zero or end measurements when the historical survey made clear that:

- Potential sources of soil pollution that are/were present.
- Potential sources of soil pollution will be present in the future.

Table 3: Quantity of boreholes and samples to be analysed near former, current or future potential point sources.

Area point source (ha)	**Quantity boreholes**			**to be**
	Borehole to 0,5 m below point source	Borehole to groundwater with standpipe	Suspected layer	ground water
<0,01	2	1	1	1
0,05-0,01	3	1	1	1
0,08-0,05	4	1	1	1
0,1-0,08	5	1	1	1

– Boreholes have to be placed systematically around/within the potential point source;
– Groundwater standpipe has to be placed downstream from the potential point source;
– Gathered point sources where activities took place with liquid substances need at least one borehole to groundwater with standpipe per individual point source;
– If during fieldwork contamination is suspected the analysis strategy has to be intensified;
– If the area of the point source is >0,1 ha a customised strategy shall be proposed by the contractor.

4.4 Further Research of Pollution Encountered

When earlier research or sensory observations indicate that soil pollution is present, further research has to take place. The design of such research depends mainly on the kind of pollution present, the physical properties of the pollutant and its appearance in the ground and/or of groundwater.

For further research, a customised strategy shall be developed by the contractor which executes the survey. The basic assumptions which should be taken into account during such research are:

- Consider the chemical characteristics of the pollutant in the design. Important properties are:
  - Density (higher or lower than water)
  - Solubility in water
  - Leaching behavior
- Carry out the survey in a grid
- Grid size depends on (suspected) extent of pollution
- Starting from the centre of the pollution boreholes should be placed in all wind directions
- In the centre / downstream from the centre of the pollution, a borehole with a standpipe has to be placed
- If pollution is encountered in the groundwater standpipes have to be included in the grid
- In all wind directions, the extent of the pollution has to be verified horizontally and vertically, both in-ground and around groundwater, by analysing the most suspected layers

It is stressed that this Guideline does not focus on further research. For every further research, a customised strategy needs to be developed by the executor of the survey. This strategy has to be included in the method statement and approved by SIPC/FZ.

5 Fieldwork

The procedures for sampling, decontamination, storage, transportation, site protection and Health and Safety issues relevant to the individual project shall be included in the method statement.

5.1 Health and Safety Precautions

The Contractor shall be responsible for familiarising his employees with the potential hazards of working on the site and shall institute necessary positive measures to ensure the safety of both, his employees and that of his own, against additional hazards.

The Contractor shall be responsible for carrying out the works in a safe and sound manner, so as to avoid risk or danger to all people employed on the Site, whether or not employed by the Contractor, and also for the general public, as per the satisfaction of the Employer's Representative.

The Contractor shall comply with all Omani legislation. The Contractor shall draw the attention of all personnel working on the survey to the nature of the possible contamination and the need to take any precautionary measures in handling the material.

Site safety measures to be adhered to during the survey shall include the following where appropriate:

- Site personnel are to wear protective overalls, safety hats, safety boots, gloves and/or barrier cream and eye protection where appropriate.
- Activities which involve hand to mouth contact, such as eating and smoking, shall be restricted to designated `clean' areas where hygiene facilities are provided.
- No naked flames, smoking or other ignition sources to be allowed on-site. Where there is a possibility that flammable vapour may be present on the site, spark arresters shall be fitted to exhausts and intrinsically safe equipment shall be used.
- When working in confined spaces or excavations, adequate precautions, including monitoring before entry and throughout the work duration, must be taken against the possible hazards of oxygen deficiency, flammable and toxic gases and dust, including asbestos.

The above list is not exclusive and does not remove any safety or environmental obligations from the Contractor.

5.2 Decontamination

All equipment to be reused at different sampling locations shall be decontaminated. Sampling equipment should also be decontaminated in between the collection of samples to prevent cross- contamination.

Decontamination shall comprise, as a minimum, the washing of collection vessels and instrument probes with de-ionised water; however, the use of decontamination fluids is preferable, such as a phosphate-free detergent solution (eg Decon 90, Camtex or similar). For larger equipment and plant a portable power washer, or steam cleaning machine may be used. Equipment should be rinsed with control water (uncontaminated water from a known source). Necessary provisions shall be made for the collection and disposal of contaminated wash water and groundwater to an approved disposal site.

Avoidance of Cross-Contamination - Borehole casing shall be used when drilling through the contaminated ground to prevent the spread of contaminants and to protect against the cross-contamination of samples.

Arisings shall be placed upon polythene sheeting and shall also be covered, to prevent the spread of contaminated material. Where necessary provision shall be made for collection and disposal of contaminated wash water and groundwater to an approved disposal site.

5.3 Soil Sampling

5.3.1 General Sampling Procedures

Volatile organic compounds (VOCs) are particularly susceptible to significant alteration and require special attention. The sample containers shall be provided on-site by the laboratory, with the appropriate preservatives already added. The sample containers shall be sealable, water-tight and robust to avoid damage during handling and transport. All samples shall be clearly labeled and suitably protected during transport to comply with the relevant regulations. The sample labels shall also carry the full sample details required by the Specification, plus the date and time of sampling. All containers shall indicate that the material is potentially contaminated. If a hazardous contaminant has been visually identified this shall be noted on the label.

5.3.2 Frequency of Soil Sampling from Exploratory Holes

Generally, samples shall be obtained at 0.5m intervals, to the maximum depth of the borehole. Additional samples shall always be collected wherever an unusual coloration, odour or soil texture is encountered.

5.3.3 Sample Sizes and Containers

Each sample taken shall be sufficient to enable all required analyses to be carried out. Multiple sample containers may be provided by the laboratory for each sample, dependent on the chemical and quality control tests to be carried out. Containers shall be compatible with the material sampled and the planned analyses to avoid cross-contamination or loss of contaminants after collection.

5.3.4 Soil Sampling Equipment

Preferably a coring device shall be used to collect the sample. Alternatively, a shovel, spade, trowel, rock pick might be used. Stainless steel or PTFE coated tools shall be used.

5.3.5 Soil Sampling from Inspection Pits

Near-surface samples shall be taken from the base or walls of the inspection pit by hand digging provided that the excavation is considered safe to enter. Otherwise, samples shall be taken at the ground surface adjacent to the pit from the backhoe excavator bucket. The base or wall of the inspection pit shall be cleaned of any loose debris in the vicinity of the sampling point before the sample is taken to ensure that the sample is representative of the stratum.

5.3.6 Soil Sampling for VOCs

Undisturbed samples are preferred for VOCs (including BTEX) to be determined; samples shall be collected in an open-ended decontaminated stainless steel cylinder, which is driven into a freshly exposed soil face. The tube shall be sealed with caps and PTFE tape. If undisturbed sampling is unsuccessful then suitable sample containers are boro-silicate glass jars with PTFE-coated lids. It is important to minimise headspace by filling the container and wrapping PTFE tape around the lid. The sample container shall be immediately placed in a cool box. At the end of each day, all samples shall be transported to the laboratory for subsequent testing.

5.4 Groundwater Sampling

Groundwater should preferably be sampled from standpipes.

If encountered during pitting or boring, groundwater samples shall always be taken. Sampling shall be undertaken using a cleaned bailer dedicated solely for the use of sampling. Wherever possible, samples shall be collected directly from the point of groundwater ingress. Care shall be taken to minimise agitation of the sample during collection to minimise the loss of dissolved gases. Groundwater shall not be collected from an excavator bucket. Before transferring water samples from sampling equipment to sample containers and/or between containers, all containers shall be rinsed thoroughly with the water being sampled. The sample will be transferred to the

container with minimum agitation to minimise the loss of dissolved gases. It is of the utmost importance that sample containers are FULL, to avoid volatilisation.

5.4.1 Equipment

The following equipment shall be available on site:

- Purging and sampling equipment as agreed with the Employer Representative.
- Water level dip meter, stopwatch, calibrated purge flow measuring device (e.g. calibrated bucket)
- Sampling bottles and septum vials appropriate to the potential contaminants.
- Sample blanks, spikes and other controls as required and specified
- Decontamination fluids, and cleaning equipment, deionised water, tap water, plus a means of disposing or removing from site decontamination fluids
- Cool boxes, pre-frozen ice packs, PTFE tape.
- Plastic tubs and glass jars (one litre capacity) appropriate to the potential contaminants
- Sample labels, chain-of-custody documents, record forms for site observations and tests.
- Electrical conductivity test meter
- Flow-through cell and combined temperature, pH, DO, Eh test instrument

In addition to the above, one or more of the following may also be required:

- Electronic interface meter for examining the free product thickness and depth to water.
- Bailer and nylon line for collecting samples of free product (1 nr per sampling point)
- FID and PID meters, with calibration gases on-site and calibration certificates.

5.4.2 Sequence of Activities

In general, at each borehole the following sequence of activities shall be undertaken:

1. In-situ test to check for VOCs using a PID, or if approved by the method statement an FID gas monitor.
2. Insitu test to check for borehole depth, free oil product thickness and water level, using an electronic interface meter.
3. If a free product is identified, sample the free product layer using a disposable bailer.
4. Purge the borehole.
5. Monitor pH, temperature, conductivity, dissolved oxygen, redox potential during purging by combined meter and flow-through cell.
6. Sample groundwater. If appropriate, recheck VOCs after purging.

Where VOC's or free products are not suspected the following sequence should be followed:

1. Insitu test to check for borehole depth, and water level, using an electronic interface meter.
2. Purge the borehole.
3. Monitor pH, temperature, conductivity, dissolved oxygen, redox potential during purging by combined meter and flow-through cell.
4. Sample groundwater.

5.4.3 Purging and On-Site Filtering or Decanting

In general, the purge volume shall be not less than 3 times the available volume stored in the piezometer standpipe and filter zone or borehole liner as appropriate. The Employer Representative may approve a smaller purge volume, provided that the Contractor can demonstrate that the piezometer has an unacceptably slow response time for refilling, or that the groundwater quality has stabilised at a smaller purge volume.

On-site filtering or decanting of water samples shall be undertaken for samples to be tested for inorganic parameters, but not for samples for organic parameters unless agreed with or directed by the Employer Representative. Filtering shall be carried out using a disposable in-line filter fitted to the sampling device. One filter shall be used per sampling point.

Where required by the Employer Representative, field measurements of pH, temperature, dissolved oxygen, redox potential and electrical conductivity (EC) shall be taken by a combined meter and flow- through cell at the start of purging, during purging and at the end of purging to assess the change and/or stabilisation in the water chemistry. The measurements shall be made in the sequence recommended by the manufacturer.

Water samples that have had field tests performed on them shall generally be collected and disposed of appropriately.

Where on-site filtering or decanting is required, two sets of samples shall be taken. One set shall not be decanted, and the other set shall be decanted in accordance with the following procedure: water samples for non-volatile organics and inorganics analyses shall be allowed to stand undisturbed for a minimum of one hour and a maximum of two hours in a refrigerator or cool box. The clarified water shall then be decanted into the sample container(s) provided by the testing Laboratory. The decanting bottles shall be disposed of after a single-use. A sample will typically have to be split into various subsamples for different analyses. All sampling containers shall be carefully and slowly filled to avoid any headspace. Water samples for volatile and semi-volatile organics analyses shall not be decanted. These sample bottles shall be sealed using PTFE tape.

Once filled, VOC septum vials shall not be re-opened.

5.4.4 At-Hole Chemical Analysis of Groundwater

Any field instruments requiring calibration shall be calibrated immediately prior to each monitoring visit, on completion of work and, if required, during work. The calibration times and readings before readjustment shall be recorded and reported along with the results so that meter `drift' can be assessed. The calibrations shall be undertaken over the most probable range expected for each determinant. Calibration certificates shall be available for inspection prior to work commencing on site. When required the following parameters are to be measured by direct reading equipment as soon as practicable after collection or by in-situ measurement of groundwater stored in the standpipe.

- pH
- Temperature
- Electrical Conductivity
- Dissolved Oxygen
- Redox potential
- Volatile Organic Gases (VOC) in air
- Oil Product Thickness

Water/oil product level measurements shall be achieved by the use of an electronic interface meter. Measurements shall be recorded for each sampling location to the nearest 1 mm. Measurements shall be referenced to the point at the top of the inner borehole casing, or other unambiguous datum points to be agreed with the Employer Representative. The meter shall be cleaned between successive sampling locations.

The Contractor shall allow adequate time for monitoring instruments to provide stabilised readings, in accordance with the manufacturer's instructions.

5.4.5 Measurement of True Oil Product Thickness

Where oil product thicknesses are directly measured more than 5mm, a bail down test shall be conducted prior to sampling of groundwater beneath the oil layer. The test shall be undertaken as follows:

Monitor the free product thickness and water level prior to bailing the piezometer or borehole. Total fluids (groundwater and free product) shall be bailed out of the standpipe so that both fluids will need time to recover. Relative depth to both oil and water shall be measured once recovery begins at the following intervals:

1, 2, 3, 5, 7, 10, 15, 30, 45 minutes,
1, 1.5, 2 hours

The test may be considered complete when three consecutive readings are stable or when recovery to about 90% of the original levels is complete. A plot shall be prepared for the values of depth to water/product interface and depth to product against time.

5.5 Field Observations and Reporting

In addition to the other requirements, the Contractor shall make detailed field observations in respect of the investigation including:-

- indications of gas evolution;
- local weather conditions including ambient temperature, barometric pressure on the day of the observation and on the previous day;
- sample temperature, colour, odour and any other pertinent factors, such as visually identified contaminants and hazardous materials;
- location and depth of sampling, date and time of sampling, sample container type;
- depth of groundwater and approximate flow rates of seepages;
- presence or evidence of liquid contaminants, e.g. free oil product;
- presence of potential pathways for contaminant migration, other than soil/rock, for example, man-made features such as abandoned services, pipework, etc.
- The condition of the monitoring points, damage, leakage from surface spills, etc.

These shall be included in the Report either on the relevant exploratory hole records or within the report text as appropriate.

Preliminary results of on-site or in-situ tests on soil, groundwater and gas, together with a cross- reference to the appropriate calibration certificates, shall be presented to the Employer Representative within 24 hours of the tests being carried out.

5.6 Sample Preservation

5.6.1 General

All samples shall be cooled and stored in the dark. Cooling to, and storing below, 4oC shall be achieved by placing the sample in a cool box with ice packs or a refrigerator. No sampling for chemical analysis purposes shall commence until sufficient cool boxes, pre-frozen ice packs, etc, together with appropriate containers are available on site.

In general, soil and groundwater samples for organics analysis (petroleum hydrocarbons, chlorinated solvents, etc) shall be placed in boro-silicate glass jars; samples for metals and inorganics analyses shall be placed in polyethylene jars. The Contractor shall include sample containers and preservation in the method statement before fieldwork commences.

5.6.2 Water Sample Preservation

The test Laboratory shall make recommendations regarding the need for preservation of water samples to preserve its condition between the field and laboratory, to ensure that the measurements made in the laboratory are as representative as possible of the field condition of the sample. The test Laboratory shall provide any necessary preservation reagents and equipment, and provide printed instructions regarding the preservation technique and sample handling.

6 Analysis

Chemical testing shall be carried out by an accredited testing laboratory selected by the Contractor and mentioned in the method statement. Samples to be identified for chemical testing will be made available for the testing laboratory. The Contractor is responsible for ensuring that sample dispatch to the laboratory occurs by the end of the shift during which they were obtained, or that suitable storage arrangements are established. Samples for chemical testing should be sampled and preserved between 2° and 4°C and tested as soon as possible after sampling.

6.1 Selection of Samples

Always in regards to contamination, most suspected samples shall be selected for analysis. The motivation for the way the sample selection was carried out has to be included in the report. Considerations for the samples to be selected for analysis might include:

- Sample with highest sensory observations of:
  - odor
  - color
  - oil-water reaction
  - quantity of material not considered soil
- Sample of the first layer below potential contaminating activity
- Sample of the layer around groundwater level
- Sample with highest PID measurement
- Etc.

6.1.1 Mixing of samples

Ground samples which, based on sensory observations, are considered clean might be mixed before analysis. This helps to raise the representatives of the survey because more samples are used for analysis. The following restrictions apply:

- The mixing and required homogenizing has to be done by the testing laboratory
- The maximum amount of samples to be mixed is three
- No mixing when contamination is suspected
- No mixing when volatile compounds might be present
- Groundwater samples can never be mixed

6.2 Testing Suites

The testing suites listed below shall be carried out on the selected soil and groundwater samples. The Contractor is responsible for technical liaison with the nominated laboratory. The following standard test suites shall be used:

Table 4: Standard test suite ground sample

Description Test	**Standard**
Metals	Aluminium, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Mercury, Nickel, Vanadium, Zinc, Silver, Manganese, Cobalt, Selenium, Antimony
(Mineral oil C5- C40 (TPH	
Aromatics	(Benzene, toluene, ethylbenzene, and xylenes (BTEX
PAH	benz(a)anthracene, benzo(a)pyrene, benzo(b) fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, acenaphthene,acenaphthylene, anthracene, benzo(ghi) perylene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene (from EPA 16)

Table 5: Standard test suite groundwater samples

Description Test	**Standard**
Metals	Aluminum, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Mercury, Nickel, Vanadium, Zinc, Silver, Manganese, Cobalt, Selenium, Antimony
(Mineral oil C5- C40 (TPH	
VOC volatile organic compounds	(Benzene, toluene, ethylbenzene, and xylenes (BTEX Chlorinated compounds

Near potential point sources, the test suites shall be adapted so that the representative potential contaminants are included in the test suite.

7 Reporting

The whole soil survey has to be reported clearly and logically.

The report of the zero or end survey shall be presented in the draft to SIPC / SFZ. The draft report shall be adapted based on comments by SIPC / SFZ.

SIPC / SFZ reserve the right to decline the report if this condition is not met or when the report does not comply with this guideline.

7.1 Main report

The following parts should be at least included in the report:

Introduction:

- Description of the kind of survey
- The objective of the survey
- Reference to this guideline
- Designation of the method statement
- Approval of the method statement by SIPC / SFZ
- Deviation of this guideline and consequences for the reliability of the results

Preliminary desk research:

- A detailed description of site inspection
- A detailed description of archive research
- Description of geology and hydrology
- Results earlier surveys (if any)
- Conclusion of desk research
- In case of an end measurement: Detailed description of the findings of the zero measurement

Research strategy:

- The chosen research strategy based on the conclusions of the desk research
- In case of further research: description and motivation of the research strategy for further research

Fieldwork:

- The period over which the fieldwork was carried out
- Description of boring method used
- General description of the soil structure and groundwater level based on the field observations done
- Description of sensory and filed observations done during the fieldwork
- The outcome of onsite measurements

Analysis:

- Description and motivation of the samples selected for analysis
- Description and motivation of the analysis suites
- The outcome of the analysis

Results and conclusion:

- Description of the findings of the survey
- Conclusion in regards to the soil (ground and groundwater) quality
- In case pollution is encountered: Estimation of the volume of polluted soil and groundwater
- In case of an end measurement: Comparison zero and end soil quality

7.2 Annexes

The following annexes shall be included:

Map(s) of the plot which includes:

- All current and former potential sources of pollution/soil threatening activities/incidents etc.
- Pavements
- Constructions present
- Boreholes (XY position with a reliability of 1 m)
- Standpipes (XY position with a reliability of 1 m)
- In case pollution is encountered: horizontal/vertical view of pollution encountered.

Records of all individual boreholes which includes:

- Description of strata
- XYZ coordinates of the borehole
- Sensory observations done during boring
- Sample intervals
- Method of boring
- Description of the standpipe including filter depth

Photos:

- Relevant photos made during the site survey and fieldwork

Analysis reports:

- Original laboratory report of all analysed samples
- In case GCMS analysis was done: chromatogram of individual samples

Annexes

1: Contact information

Annex 1: Contact information

For information on this guideline and the history of a site:

SOHAR Port/Freezone

Environmental Department

environment@soharportandfreezone.com

Sohar Port and Freezone

PO Box 9, PC 327, Sohar

Sultanate of Oman"

For information on pipelines and cables:

SIPC / SFZ

Asset Management Department Site Operations Unit

Tel: 26852779, or 26852750

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