Earth & Marine Environmental Consultants

Chapter 6 – Land

Contents

6 Land

6.1 Introduction

This chapter of the ESIA report discusses the historical and current use of the site with respect to land quality, sediment quality and waste management. It details the objectives, methodology and findings of these assessments and also considers the potential impacts of the proposed Terminal construction and operational activities on the land quality conditions at the site. Note that this chapter deals with physical and chemical impacts, ecological impacts associated with land take and earthworks are dealt with in *Chapter 8 - Ecology*.

6.2 Land Quality

This section describes the underlying geology, geomorphology and soil conditions as well as establishes the present nature, extent and significance of contamination that already exists on the site such that a baseline is established against which project impacts can be evaluated. The contamination assessment also considered groundwater beneath the site but the discussion of this is presented in *Chapter 7 – Water Quality*.

6.2.1 Assessment Methodology

Baseline Conditions

This study involved a combination of desk-based studies, consultations with stakeholders, review of previous investigation reports and soil sampling and testing and associated analysis and risk assessment.

EAME undertook a comprehensive desk study[1] of the proposed Terminal covering a large number of relevant topics. The information obtained during this study enabled EAME to design a sampling programme to provide additional information on the baseline conditions of the area and supplement data obtained from previous investigations.

This assessment has been undertaken in accordance with current guidance on EIA[2] and has involved a review of the following sources of baseline data:

- Site walkovers undertaken in August and September 2014 to provide an assessment of current site activities and the site's environmental setting;
- Desk-based research;

[1] WTPS Iraq Oil Terminal Desk Study, Earth & Marine Environmental Consultants, August 2014, REF: 014-1287 REV00

[2] Environmental Impact Assessment – A Guide to Procedures, DETR, November 2000

- Review of a previous geotechnical site investigation report; and
- Conversations with port staff and local communities.

Based upon the desk based risk assessment, an environmental site investigation, undertaken in August 2014, was designed to provide additional data in order to develop a conceptual site model and allow sufficient characterisation of the site to adequately identify contamination risks, establish baseline conditions against which impacts could be assessed and develop appropriate mitigation measures. This study comprised the following elements:

- The drilling and installation of seven sentinel boreholes to 6m below ground level (bgl) to enable an assessment of the prevailing soil conditions (shallow soils and underlying natural strata) and groundwater conditions. All drilling works were conducted using clean drilling methods *i.e.* no oils or other contaminative fluids were used or added during drilling. Each borehole was installed to facilitate follow-on groundwater monitoring;
- Soil samples were collected from within the top 1.0m, a change in strata and at any depth where visual or olfactory evidence of contamination was identified or there were obvious changes in strata. Nitrile gloves were worn during the sampling itself and were changed regularly to further prevent any anomalies in the data *via* contaminant transfer. The samples were examined by an experienced EAME field scientist and inspected for visual and olfactory evidence of contamination;
- Soil arisings from the exploratory hole locations were examined visually and unusual odours (if any) were also noted. The soils encountered were logged broadly in accordance with BS EN ISO 14688-1:2002 and BS EN ISO 14688-2:2004, which has partially superseded BS 5930:1999, however, this standard does not cover descriptions of manmade or reworked materials and was written principally for engineering purposes. There are no equivalent Iraqi standards;
- In addition, EAME collected twenty surface soil samples; this is on the basis that this is a baseline study rather than a campaign to identify the spatial extent of suspected contamination from previous installations (which would require a greater level of sampling). The surface sampling was undertaken using a stainless steel trowel which was decontaminated between locations so as to prevent any cross-contamination;
- Selected samples were tested by dynamic headspace analysis, for the presence of volatile organic compounds using a Photo-Ionisation Detector (PID). Dynamic headspace analysis refers to the manual agitation of a bagged soil sample to facilitate

the volatilisation of organic compounds present in the soil into the headspace above (*i.e.* soil gas) which is then analysed using the PID. The PID screens for a wide range of volatile organic compounds including hydrocarbon compounds and certain chlorinated solvents, but does not indicate a specific compound. The measurements obtained by the instrument in parts per million by volume (ppmv) provide a semi-quantitative indication of the concentration of hydrocarbon vapours that are present in the soil pore spaces;

- Submission of soil samples to an accredited independent laboratory. A total of thirty-four soil samples were submitted to the laboratory for analysis including metals and metalloids, asbestos, pH, Sulphate, Chloride, Phosphate, Monohydric Phenols, Cyanide, Speciated Polycyclic Aromatic Hydrocarbons (PAHs), Total Petroleum Hydrocarbons (TPH) (C_{10} – C_{40}), Volatile Organic Compounds (VOCs) and Semi Volatile Organic Compounds (SVOCs); and

- Furthermore, EAME recommended that the possible discharge and accumulation of radioactive nuclides in the landscape should be assessed as part of the project to monitor possible radioactive contamination of the landscape. All surface soil samples sent to the laboratory were screened for radioactivity, the purpose of which was to measure levels of NORM across the study area. Measurements were collected using an energy-compensated pulse rate “micro-R” meter that provides a scaled reading in microroentgen per hour (µR/hr).

Following the desk study and environmental site investigation, a review of the findings was undertaken in the context of current guidance (and in the absence of any specific Iraqi legislation), to identify potential impacts and enable an assessment of potential impacts and define mitigation measures where necessary.

Photograph 6.1: *Drilling Rig Operating BH02*

Assessment Criteria

There are presently no soil contamination standards or land quality regulations in Iraq. In the absence of country specific standards, it is normal (best) practice for the assessment of contaminated soils to adopt a risk-based approach which is structured in a tiered manner. As well as having a systematic approach to collecting the data it is also necessary to adopt recognised techniques and standards in assessing them and particularly with regard to environmental risk assessment.

Table 6.1: Tiered Assessment	
Tier 1 Assessment	Comparison of site contaminant concentrations against generic standards and compliance criteria including an assessment of risk using the source pathway target model.
Tier 2 Assessment	Derivation of site specific risk assessment criteria and calculation of site specific clean up goals where Tier 1 values are exceeded.

The information gathered during the desk-based review and site investigation was utilised to develop a conceptual site model based on the risk assessment principle of identifying significant Pollutant Linkages. In other words where there is a pollution source and a sensitive receptor that could suffer harm from that source if a suitable pathway connects them, then there is a significant pollutant linkage and thus an unacceptable risk that requires mitigation.

The Ministry of Oil ((MoO), in the absence of any promulgated national standards has adopted the internationally recognised Dutch Intervention Guidelines indicator values (2000) for determining 'significant' level of impact in relation to impairing multi-functional land uses; however, such guidelines are not wholly appropriate in the context of this project and values do not exist for all contaminants. Such an approach is outdated and runs contrary to widely adopted risk-based approach applied in most jurisdictions now.

As such, EAME have utilised the following multiple screening criteria to try and provide a benchmark for assessing whether or not the chemical species levels found in the site soils should be regarded as significant contamination for environment assessment purposes:

- Dutch Intervention Guidelines (Department of Soil Protection, 2000) for 'significant' level of impact likely to impair multi-functional end-uses[3];
- US EPA (2010) Regional screening values for chemical contamination of industrial soil, Region 9[4]; and
- Australian National Environmental Protection Council (NEPC), Guidelines for Investigating Contaminated Soil and Groundwater, Health-based Investigation Level (HIL) - F – Commercial/Industrial (NEPC, 1999)[5].

Whilst these guidelines are not directly applicable, they do provide a useful range of indicator values in the absence of Iraqi promulgated standards and help to put the levels observed in context.

Identification of Impacts

The effects on ground likely to arise from the construction and operational phases of the proposed development are principally the following:

- the potential movement and dispersion of material in the various media during the construction phase from earthmoving and general construction works;
- potential for piling and dewatering of excavations to enable cross contamination of the ground strata;
- Introduction of new contaminants in the form of spilled oils, fuels and construction related wastes; and

[3] http://www.esdat.net/Environmental%20Standards/Dutch/annexS_I2000Dutch%20Environmental%20Standards.pdf
[4] http://www.epa.gov/region9/superfund/prg/
[5] Schedule B1 - Guideline on Investigation Level for Soil and Groundwater, National Environmental Protection Council, Federal Register of Legislative Instruments, F2013C00288, 1999

- mobilisation of contaminants and leaching through the sub strata to impact identified controlled waters, such as surface watercourses and groundwater bodies by the creation of new pathways.

Assessment and Evaluation of Effects

The assessment of effects has involved the following general approach:

- the identification and assessment of potential sources, pathways and receptors in relation to the proposed end use of the site during and following development;
- the sensitivity of receptors has been established on the basis of their nature, proximity to the site, existing quality or resource value and consideration of potential pathways;
- evaluation of the significance of the potential changes in ground levels, earth moving activities and assessment of the sensitivity of the resource to the predicted changes;
- the potential effects have been classified, prior to mitigation, as minor, moderate or major (either positive or negative); and
- where the predicted effects are considered to be significant, mitigation measures have been recommended to eliminate or reduce the impacts to an acceptable level. The residual effects (post mitigation) are discussed in the final subsection of this chapter.

6.2.2 Baseline Conditions – Desk-based Research and Site Walkover

This section provides a summary of relevant information arising from the desk study which preceded the intrusive site investigation works.

Site Walkover

The site is irregular in shape and covers a total area of approximately $0.95km^2$. The majority of the site, approximately 95%, is undeveloped and vacant with sparse halophytic vegetation, unsurfaced access roads and evidence of fly-tipped waste. There is evidence of disturbance of some of the soils by heavy plant and some accumulations of earth mounds from earthworks activities. Also there is an earth bank road running along the site parallel to the shoreline with two smaller earth bank roads extending to the water line.

The northern elevation of the site comprises KAZ Jetty No. 1 (see *Photograph 6.2*) and areas of unsurfaced, derelict land with areas utilised for the storage of scrap metal, much of which appears to be marine-derived (see *Photograph 6.3*). During the site walkover, fragments of suspected asbestos sheeting were noted within the area of the scrap metal storage (see *Photograph 6.4)*.

The intertidal zone is littered with domestic waste deposited by the river as well as large metal objects such as redundant pipework (see *Photograph 6.2*).

Photograph 6.2: *Looking northwards along the intertidal zone towards KAZ Jetty No. 1. Please note the redundant pipework.*

Photograph 6.3: *Scrap metal storage*

Photograph 6.4: *Suspected Asbestos sheeting*

Furthermore, three shipwreck fragments, from the vessel *Palestine*, are present in the intertidal zone, these are currently supposed to be in the process of being removed by GCPI (for onward shipment to the steel works for processing), however, is understood that this process has been halted at present. It is not known when it will resume.

Photograph 6.5: *Shipwreck sections from the Palestine located on the intertidal zone*

Historical Site Use

It is understood that the majority of the site has never been developed, however, the site walkover, various maps of the region and remote sensing data has indicated signs of anthropogenic impacts including fly tipping/dumping, off road vehicle activities and the remnant signs of war. Consequently, whilst the site as a whole may be regarded as "greenfield" developmentally, it is a site that has been disturbed by a number of activities.

Geology and Geomorphology

The Khor Al-Zubair area is one of the largest zones of tidal mud flats in the north-western Arabian Gulf. These estuarine and marine deposits form the extreme south-eastern boundary of the larger Mesopotamian Plain. The Plain is a vast lowland area with clearly defined physiographic and structural boundaries and an imperceptible gradient from northwest to the southeast towards to the Persian Gulf. The Plain is considered to be a huge aggradational geomorphologic unit; where the fluvial, lacustrine and Aeolian landforms prevail, however, estuarine and marine units are also present[6].

The structural setting of the Khor Al-Zubair is the result of the formation of a fault structure which represented an extension of the ancient Euphrates river course[7]. The uplift of the adjacent areas around the Khor Al-Zubair and the subsidence of others led to the propagation of the sea level and disconnection from the River Euphrates. Subsequently, the Khor Al-Zubair become an elongated marine lagoon[8]. However, since 1983, the Khor Al-Zubair has been connected to the Shatt Al-Basra Canal, converting it from a marine lagoon into an estuary.

Dibddiba Formation is the result of a giant, triangular-shaped alluvial fan of the Wadi ar Rimah-Wadi al Batin drainage system which is the longest ephemeral watercourse in Arabia, draining most of the northern Arabian Shield. The fan extends over parts of Saudi Arabia, over most of Kuwait and south-east Iraq, where it has deflected the course of the Euphrates causing the formation of the Haur Al-Hammer Lake. The Formation was formed by sheet floods during the Pleistocene with sandy horizons representing periods of reduced precipitation[9].

[6] Geomorphology of the Mesopotamia Plain, Yacoub S. Y., Iraqi Bulletin of Geology and Mining, Special Issue No. 4, 2011

[7] Khor Al-Zubair Classification and Possibility to Detection Dimensions during Stages of Different Tectonic Development, Al-Mosawi S.N., Third Symposium about Marine Natural of Khor Al-Zubair, Marine Sciences Centre,/Basra University, 1991

[8] Sedimentological and mineralogical Study of Rocky Island in Khor Al-Zubair Area north-west of the Arabian Gulf, Wasil S.A., M.Sc. Thesis, Basra University, 2003

[9] Arabian Deserts: Nature, Origin and Evolution, Edgell H. S., Springer, 2006

Alluvium and Aeolian Deposits

The sediments of the tidal flats comprise an upper layer which is approximately 6 - 8m thick, sequentially underlain by the Hammar Formation and the Dibdibba Formation.

The general area surrounding the Project site is overlain by recent estuarine and marine alluvium which predominantly comprises clay and silt with some sand and pebbles[10.] The clay and silt fractions predominant and the deposits are commonly lenticular, poorly indurated and nearly flat lying. The upper 1m of the alluvium contains abundant salt and gypsum crystals[11].

Hammar Formation

The Hammar Formation (also known as Mesopotamian Plain Alluvium) is from the Pleistocene Age[12] and predominantly comprises lacustrine deposits (silts and clays) which have been deposited in a uniform and consistent manner[13].

Dibdibba Formation

The Dibdibba Formation comprises '*mainly sand and gravel of igneous rocks, including pink granite, various liver-coloured and slate-grey intrusive, dolerites, etc., and white quartz pebbles. Not infrequently the rock is cemented to a hard grit'*[14]. The formation is between 30 – 260m thick[15], however, wells from the Zubair oil field indicate that it is up to 354m thick[7]. The aforementioned hard grit is likely to be due to gypsum acting as a cementing agent between soil particles.

[10] Physical Characteristics of Mesopotamian Marshlands of Southern Iraq, The Iraq Foundation, January 2003
[11] Geology of the Arabian Peninsula Southwestern Iraq, Naqib K. M., U.S. Geological Survey Professional Paper 560-G, 1967
[12] Sedimentation in lakes and marshes (Ahwar) of the Tigris-Euphrates Delta, southern Mesopotamia, Aqraqi A. A. M and Evans G. 1994
[13] Some Geotechnical Soil Properties of Western Bank of Khor Al Zubair Channel Coast at Khor Al Zubair Port Location, Southern Basrah, Iraq, Muttashar W. R., Mesopotamian Journal of Marine Science, Volume 25, 2010
[14] Water Supplies in Iraq, Macfadyen W. A., Iraq Geology Department, 1938
[15] Hydrogeology of Al-Basrah Area, Krasny J., Iraq GEOSURV, Number 1337, 1982

6.2.3 Baseline Ground Conditions

Borehole Locations

All seven boreholes were drilled between the 13th and 15th August 2014.

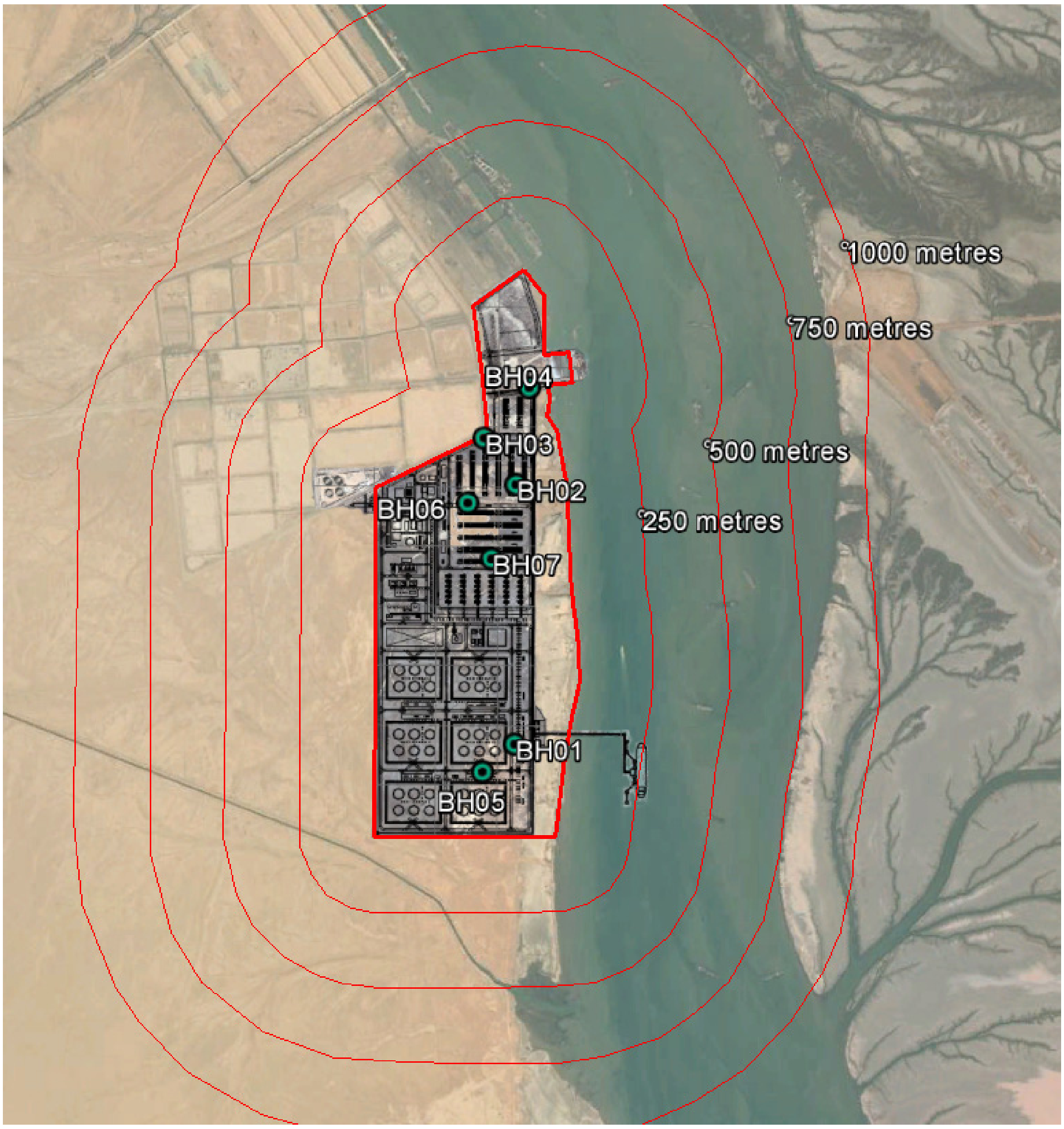

Figure 6.1: *Borehole locations*

Google Earth Pro Imaging with the permission of Google Licensed to Earth and Marine Environmental Consultants Ltd

The rationale for the borehole location is presented in *Table 6.2*.

Table 6.2: Borehole Location and Rationale				
Location ID	**Easting, Northing**	**Latitude, Longitude**	**Elevation (m IGRS)**	**Rationale**
BH01	778507.201 3341149.746	30°10'12"N 47°53'33"E	3.709	Close to the Khor Al-Zubair
BH02	778489.365 3342026.42	30°10'40"N 47°53'31"E	4.628	Close to the Khor Al-Zubair
BH03	778405.253 3342177.245	30°10'45"N 47°53'27"E	5.228	Boundary with the Freezone
BH04	778521.197 3342333.51	30°10'38"N 47°53'25"E	4.276	Targeting part of the site currently utilized
BH05	778410.867 3341038.085	30°10'09"N 47°53'27"E	4.09	Spatial coverage
BH06	778349.064 3341969.954	30°10'38"N 47°53'25"E	4.686	Spatial coverage
BH07	778399.976 3341775.446	30°10'32"N 47°53'28"E	4.851	Spatial coverage

Surface Soil Sample Locations

The surface soil samples were collected on the 11th August 2014.

Field observations and measurements of the surface soil samples are presented in *Table 6.3*. The samples were collected from across the site in an approximate grid pattern in order to provide spatial coverage.

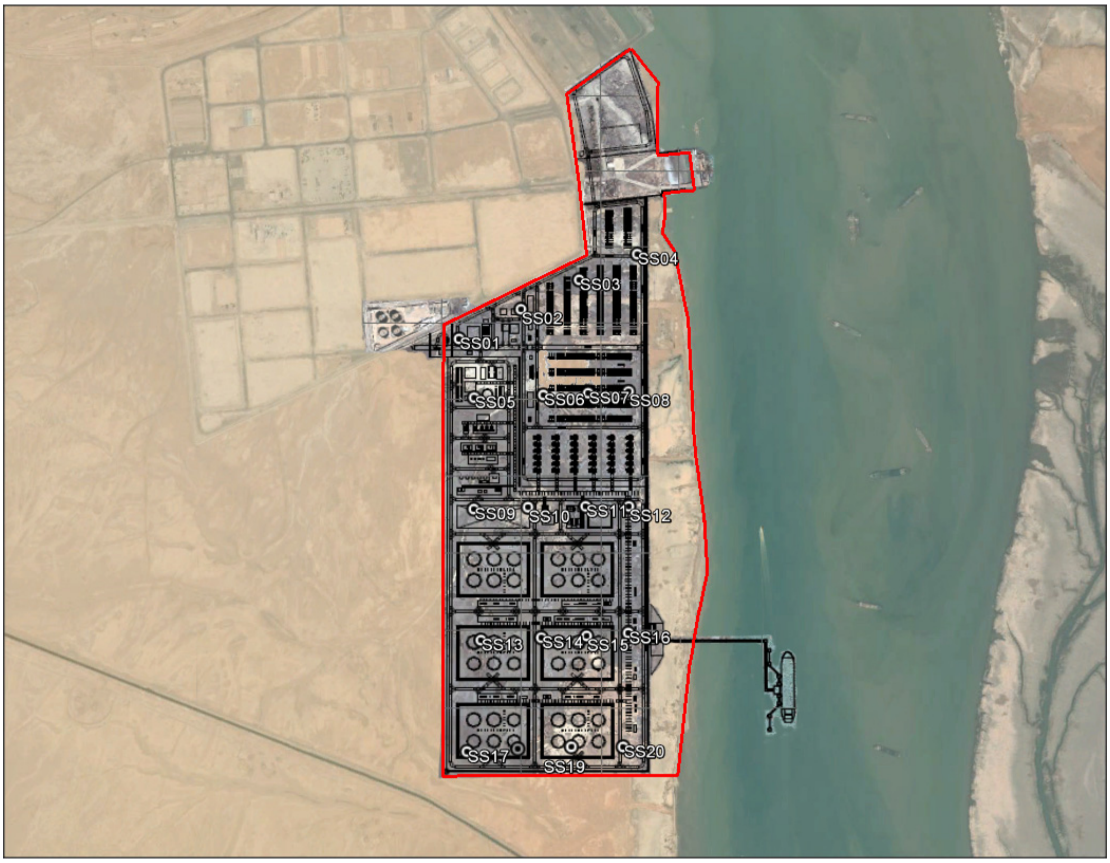

Figure 6.2: *Surface soil sample locations*

Google Earth Pro Imaging with the permission of Google Licensed to Earth and Marine Environmental Consultants Ltd

Table 6.3: Surface Soil Samples Field Observations and Measurements

Sample ID	Grid Reference	Description	Munsell Colour	PID Reading
SS01	30°10'38.29"N, 47°53'14.96"E	Dry light grey – brown fine sandy SILT	10YR 7/2 Light gray	<0.1
SS02	30°10'40.79"N, 47°53'20.98"E	Dry light grey – brown fine sandy SILT	2.5Y 7/2 Light gray	<0.1
SS03	30°10'43.27"N, 47°53'26.65"E	Dry light grey – brown fine sandy SILT	2.5Y 7/2 Light gray	<0.1

Table 6.3: Surface Soil Samples Field Observations and Measurements

Sample ID	Grid Reference	Description	Munsell Colour	PID Reading
SS04	30°10'45.46"N, 47°53'32.32"E	Dry light brown – yellow fine sandy SILT	2.5Y 8/3 Pale yellow	<0.1
SS05	30°10'33.33"N, 47°53'16.44"E	Dry grey – light brown fine sandy SILT	2.5Y 6/1 Gray	<0.1
SS06	30°10'33.55"N, 47°53'23.16"E	Dry grey – light brown fine sandy SILT	2.5Y 6/1 Gray	<0.1
SS07	30°10'33.71"N, 47°53'27.52"E	Dry grey – light brown fine sandy SILT	2.5Y 5/2 Grayish brown	<0.1
SS08	30°10'33.86"N, 47°53'31.44"E	Dry grey slightly gravelly sandy SILT	10YR 8/4 Very pale brown	<0.1
SS09	30°10'23.98"N, 47°53'16.44"E	Dry grey coarse SAND with salt crystals	10YR 8/4 Very pale brown	<0.1
SS10	30°10'24.13"N, 47°53'21.68"E	Dry grey coarse SAND with salt crystals	10YR 6/2 Light brownish gray	<0.1
SS11	30°10'24.21"N, 47°53'27.26"E	Dry light brown slightly gravelly fine sandy SILT	10YR 8/4 Very pale brown	<0.1
SS12	30°10'24.20"N, 47°53'31.44"E	Dry grey – light brown fine sandy SILT	5Y 7/2 Light gray	<0.1
SS13	30°10'13.05"N, 47°53'17.14"E	damp brown silty soft CLAY	10YR 8/4 Very pale brown	<0.1
SS14	30°10'13.26"N, 47°53'22.97"E	Dry grey – light brown fine sandy SILT	2.5Y 7/1 Light gray	<0.1

Table 6.3: Surface Soil Samples Field Observations and Measurements				
Sample ID	**Grid Reference**	**Description**	**Munsell Colour**	**PID Reading**
SS15	30°10'13.41"N, 47°53'27.34"E	Dry grey – light brown coarse sandy SILT	2.5Y 7/1 Light gray	<0.1
SS16	30°10'13.65"N, 47°53'31.36"E	Dry grey – light brown fine sandy SILT	2.5Y 5/2 Grayish brown	<0.1
SS17	30°10'3.82"N, 47°53'15.82"E	Dry light brown fine sandy SILT	2.5Y 8/4 Pale yellow	<0.1
SS18	30°10'4.06"N, 47°53'20.71"E	Dry light brown fine sandy SILT	10 YR 8/4 Very pale brown	<0.1
SS19	30°10'4.23"N, 47°53'25.86"E	Dry light yellow – light brown coarse sandy SILT	2.5Y 8/2 Pale yellow	<0.1
SS20	30°10'4.22"N, 47°53'30.83"E	Dry light grey – light brown fine sandy SILT	10YR 8/4 Very pale brown	<0.1

Ground Conditions

The ground conditions at the site were found to be broadly consistent with published information. In summary, the top 1.0m comprised loose gravelly coarse SAND, typically underlain by silty CLAY or clayey SILT. No rockhead was encountered during the investigation. The borehole lithological logs are presented in *Appendix G1*.

The surface soil samples were noted to be predominantly grey – brown fine sandy SILT with a highly desiccated crust and salt crystal inclusions.

Field Evidence of Contamination

No visual or olfactory observation of potential contamination was observed in terms of oil or chemical staining or odours, furthermore, no VOC readings, above the instrument's level of detection (>0.1 ppmv), was noted.

6.2.4 Baseline Conditions – Chemical Contamination

Analytical Strategy

In total, fourteen soil samples, two from each borehole, and the twenty surface soil samples were submitted for chemical analysis. The analytical strategy was designed by EAME to provide an assessment of the presence of a common range of potential contaminants.

Table 6.4: Analytical Strategy

Parameter	Rationale
General Inorganics pH, Total Cyanide, Complex Cyanide, Free Cyanide, Total Sulphate as SO_4, Total Chloride, Water Soluble Phosphate as P (2:1), Total Nitrogen (Kjedahl), Total Organic Carbon (TOC)	Commonly associated with industrial sites
Asbestos Screen and Identification (5 samples)	Associated with general fill material, demolition wastes and ship scrap
Total Phenols (Monohydric)	Commonly associated with industrial sites
Total Speciated PAHs	Speciated suite to determine the presence of fuel derivatives and associated compounds
Heavy Metals and Metalloids	Commonly associated with industrial sites
Total Petroleum Hydrocarbons (C_{10} – C_{40})	Targeted analysis for fuels and oils
VOCs	Targeted analysis for fuels and oils
SVOCs	Targeted analysis for PAH compounds and phenols
Radiation Screening	Targeted analysis for NORMs and DU remnants

Assessment of Analytical Results

EAME has used a tiered approach in order to assess the analytical data and provide a preliminary qualitative assessment of the soil analytical results. This has focussed on risks to human health assuming a future industrial land use (as opposed to a more sensitive but unlikely residential end use).

The first stage of assessment was to screen out those compounds that were not present above the method detection limit (MDL) of the laboratory. These are provided in the list below, and have thus not been considered further within the assessment and are assumed to not be present on the site in significant concentrations.

- Cyanide (Total, Complex and Free);
- Total Phenols (Monohydric);
- Speciated PAHs;
- Cadmium
- Chromium;
- Mercury;
- Tin;
- Total Petroleum Hydrocarbons C_{10} - C_{40};
- VOCs;
- SVOCs; and
- Radiaiological Species.

The remaining determinants that were present above the laboratory MDL were then compared against a screening criteria value, where available. The samples were tested at an accredited UKAS laboratory (i2 Analytical), with the full analytical certificates presented in *Appendix G2* and summarised in *Table 6.6*.

Table 6.6: Summary of Soil Analytical Results

Contaminant	Conc. Range (mg/kg)	Location of Sample with Max. Conc.	Screening Criteria	No. of Exceedances of Screening Criteria
General Inorganics				
pH	7.4 – 8.4	BH05: 0.5 – 1.0m	NG	-
Total Sulphate as SO_4	1,900 – 72,000	BH04: 0.5 – 1.0m	NG	-

Table 6.6: Summary of Soil Analytical Results

Contaminant	Conc. Range (mg/kg)	Location of Sample with Max. Conc.	Screening Criteria	No. of Exceedances of Screening Criteria
Total Chloride	870 – 22,000	BH05: 0.5 – 1.0m	NG	-
Water Soluble Phosphate as P (2:1)	<MDL – 0.59	BH03: 1.0 – 1.5m	NG	-
Total Nitrogen (Kjeldahl)	160 - 620	BH02: 3.0 – 3.5m	NG	-
TOC	0.3 – 2.0%	SS09, SS20	NG	-
Asbestos				
Asbestos Screen and Identification	Present: chrysotile – loose fibres	1 location only (SS03)	NG	-
Heavy Metals and Metalloids				
Arsenic	1.5 – 6.6	BH05: 0.5 – 1.0m, SS06	55 *1	*0*
Copper	5.8 - 34	SS07	190 *1	*0*
Iron	4,500 – 30,000	SS07	NG	-
Lead	<MDL – 46	SS03	530 *1	*0*
Manganese	79 - 440	SS07	7,500 *2	*0*
Nickel	12 - 100	SS07	210 *1	*0*
Tin	<MDL – 1.3	SS04	NG	-
Zinc	11 - 120	SS03	720 *1	*0*

Notes:

*1 Dutch Intervention Values

*2 NEPC

Units are mg/kg except where indicated otherwise

NG = No Guideline available

<MDL = Below the Method Detection Limit

Conceptual Site Model

The ground conditions on the site, as determined through the site investigation process, have been summarised into a Conceptual Site Model (CSM), which defines the key sources, pathways and receptors that have been identified as being relevant to this site. The CSM within this chapter summarises the following:

- the identification of contaminants within the soil that represent potential pollution sources;
- the identification of the potential exposure pathways between the potential sources;
- the identification of the potential receptors for the contamination; and
- the identification of potential pollutant linkages.

All discussions in this section have been made in relation to the site's proposed industrial/commercial setting.

Identification of Soil Contaminants (Potential Sources)

The only potential sources of contamination identified relates to the asbestos fibres located on the northern elevation of the site as all other parameters were recorded at concentrations below the relevant screening criteria are not considered to be environmentally significant.

Potential Receptors

Based on the site's environmental setting and the proposed future end use of the site following redevelopment, the following receptors have been identified:

- Groundwater;
- Surface water;
- Current site works and trespassers;
- Future site workers (*i.e.* future employees located at the site);
- Future on-site buildings and services;
- Groundworkers *(i.e.* construction workers, maintenance workers or other personnel who may be directly exposed to contaminated soil in the course of their activities);

- Local flora and fauna whose habitat could be damaged or altered by chemical contamination;
- Third party land (*i.e.* the possibility of contamination migrating off-site onto third party via contaminated groundwater); and
- Risks to water resources are reported within *Chapter 7: Water Quality.*

It should be noted that there is little if any potential for the on-site contamination to impact upon human health in the off-site community as there is no evident on site source or nearby residential community and no plausible pathway exists for impact on the nearest residential community, even if a source were present. This has thus been discounted as a potential receptor. It is recognised, however, that there may be dust emissions during construction works, however, with sensitive receptors at least 5km distant, it is unlikely that emissions of dust would cause a nuisance. Nevertheless, it should be noted that mitigation measures will be included as part of the Construction Environmental Management Plan (CEMP) which will reduce the level of impact.

Identification of Potential Exposure Pathways

Exposure pathways are the potential routes that link the potential on-site sources to the identified potential receptors. However, it should be stressed that these risks have to be considered only through plausible pathways. The following potential exposure pathways have been identified at the site:

- Inhalation, ingestion or skin contact with contaminated soils and dusts (although generally risks to construction workers or maintenance workers should be manageable by standard health and safety procedures such as wearing appropriate PPE and observing normal site hygiene practices);
- Migration of soil contaminants v*ia* transmission along conduits; and
- Migration of contaminated horizons with uncontaminated horizons through piling activities.

Potential Pollutant Linkages

In order for there to be a plausible pollutant linkage there must be a source, receptor and pathway and a feasible linkage between them (a so called pollutant linkage). Consequently, even where a contaminant is identified, if there is no pathway for the contamination to reach a receptor, or no receptor then there can be no significant risk and remedial actions are not required. Furthermore, even if there is a complete pollutant linkage, it is possible that the contaminant concentration that can pass along the linkage does not represent a significant risk to human health or the environment. Central to this risk assessment process is the development of a 'conceptual model'. This is a descriptive and/or pictorial representation of the area of potential contamination, the surrounding environment and the processes acting on the contaminants by which they can move and come into contact with receptors (*e.g.* by leaching and migration into groundwater).

Production of a conceptual model requires an assessment of risk to be made. Risk is a combination of the likelihood of an event occurring and the magnitude of its consequences. Therefore, in order to assess risk both the likelihood and the consequences of an event must be taken into account. This report adopts the methodology for risk evaluation presented in CIRIA report C552 'Contaminated Land Risk Assessment – A Guide to Good Practice', 2001. The method is qualitative and involves the classification of the following:

- the magnitude of the potential severity or consequence of the risk occurring (*Table 6.7*);
- the magnitude of the likelihood or probability of the risk occurring (*Table 6.8*); and
- once the likelihood of an event occurring and its severity have been classified, a risk category can be assigned using *Table 6.9*.

Table 6.7: Classification of Consequence

Consequence	Definition
Severe	Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short term risk of (significant) pollution of sensitive water resource. Catastrophic damage to building/property. A short term risk to a particular ecosystem, or organism forming part of such ecosystem.
Medium	Chronic damage to human health (significant harm). Pollution of sensitive water resources. A significant change in a particular ecosystem, or an organism forming part of such an ecosystem.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/services or the environment.
Minor	Harm, although not necessarily significant harm, which may results in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.). Easily repairable effects of damage to buildings, structures and services.

Table 6.8: Classification of Probability	
Likelihood	**Definition**
High	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period that such an event would take place and is even less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 6.9: Risk Assessment Matrix					
		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Likelihood of Occurrence	**High**	Very High	High	Moderate	Moderate/Low
	Likely	High	Moderate	Moderate/Low	Low
	Low	Moderate	Moderate/Low	Low	Very Low
	Unlikely	Moderate/Low	Low	Very Low	Very Low

EAME has devised a conceptual model based on the information obtained through the site investigation and is based on future commercial/industrial redevelopment. This is detailed in tabular format in *Table 6.10*.

Table 6.10: Conceptual Site Model – Current Site Conditions			
Source			
(A) Presence of chryostile fibres on the northern elevation of the site			
Source	**Pathway**	**Receptor**	**Potential Pollutant Linkage and Significance**
(A)	Ingestion Inhalation	**<u>Human Health (HHR)</u>** Current site works and trespassers Off-site general public	**<u>HHR – High Risk</u>** During the site investigation, asbestos fibres were recorded on the northern elevation of the site. Asbestos sheeting was observed in close proximity. There is a risk of exposure if asbestos contaminated materials are disturbed in close proximity to site workers.

No other risk scenarios were identified.

Summary of Chemical Baseline Conditions

In summary, none of the samples recorded concentrations above their respective screening criteria for risk to human health (where published criteria exist). It is notable that none of the samples were positively identified in the radiation screening as having detectable radioactivity.

Cemented asbestos sheeting was observed within the area of scrap metal storage on the northern elevation of the site (see *Photograph 6.4*). As such, a number of samples were submitted for asbestos screening, one sample, SS03, was found to contain loose chrysotile fibres.

From a baseline assessment perspective it can be concluded from the soil survey that the site is effectively uncontaminated with any of the species targeted for analysis and in that regard there are no obvious contamination legacy issues that need to be addressed as part of the site development works.

It should be noted, however, that there is a possibility of contamination in the scrap metal waste area. It was not possible to sample beneath the scrap metal and there is a possibility of asbestos and hydrocarbon contamination in this area.

6.2.5 Impact Assessment

The impact assessment in the context of an ESIA, considers the potential for the development proposals to impact on the baseline conditions. In addition to the potential pollution sources that already exist at the site (which other than localised asbestos are negligible), the following potential sources of pollution may arise as a result of the construction and operational phases of the proposed development impacting upon the site.

Table 6.11: Potential Future Sources of Soil Contamination at the Site

Construction Phase	Operational Phase
Spillages of polluting materials during construction activities (e.g. fuel spills during plant refuelling).	Poor housekeeping operations or the occurrence of spillages such as fuel and oil leaks
Mobilisation of oil residues in scrap vessels stored on the site.	Transfer of petroleum products from marine tankers to tanks
	Storage of petroleum products
	Transfer of petroleum products from tanks to road tankers

When the proposed Terminal is closed and decommissioned (and possibly demolished), there may be impacts associated with this too if residual materials are not removed from the site and mismanaged. The activities that would typically be involved in the closure and decommissioning of such a facility would be similar to those during construction, involving plant and machinery, earthworks, materials movement and management. Likewise, therefore, the impacts would be similar. It is unlikely that a site such as this would be returned to the status of the present undeveloped site. Whilst potentially polluting materials and valuable or recyclable infrastructure (for example, tanks, pipes, scrap metal, machinery, plant) will be removed, the major structures (concrete, berths, drainage systems, walls, fences, etc) would be unlikely to be removed. In all likelihood, the site would probably be re-used for alternative uses or redeveloped. As such the extent of the works and associated traffic and construction type activities (machinery, earthworks, etc) associated with closure of the facility, whilst similar in nature to the construction activities, are expected to be lesser in scale and duration, as would be the associated impact. It is considered, therefore, that the impact of closure and decommissioning activities upon the terrestrial environment will be negligible.

6.2.6 Mitigation

The site's redevelopment proposals will mitigate the key pollutant linkages of human health exposure and on-site buildings and services. This is detailed in *Table 6.12:*

Table 6.12: Conceptual Site Model – Potential Impacts Following Site Development

Source			
(A) Presence of chryostile fibres on the northern elevation of the site			
Source	**Pathway**	**Receptor**	**Potential Pollutant Linkage and Significance**
(A)	Ingestion Inhalation	**Human Health (HHR)** Current site works and trespassers Off-site general public	**HHR – Low Risk** The asbestos sheeting and impacted areas will be further investigated and removed as part of the development works and thus eliminated as a source.

Consideration has also been given to the mitigation of potential impacts associated with the construction phase of the site's redevelopment in addition to the operational phase of the site following its redevelopment.

Construction Phase

Construction vehicles will be properly maintained to reduce the risk of hydrocarbon contamination and will only be active when required. Construction materials will be stored, handled and managed with due regard to the sensitivity of the local aquatic environment, thus, the risk of accidental spillage or release will be minimised.

Furthermore, mitigation measures will be incorporated into a CEMP, which sets out measures for the control of site drainage, reducing the risk of accidental spillages and the storage and handling of materials.

No underground storage tanks will be used during the construction phase. Any liquids such as degreasers, oils, diesel, required as part of the construction works will be stored in above ground tanks and located on designated areas of hardstanding.

Operational Phase

Hydrocarbon contamination from the on-site storage tanks (and associated transfer from marine tanker to tankage and then to road tankers) is considered to be a potential source of contamination from the routine operation of the site. The proposed Terminal will utilise industry standard equipment, thereby, reducing the potential risk of contamination, particularly when compared to the existing facilities. Furthermore, once operational, the terminal will operate relevant response procedures which, if needed, will react to reduce the impact of any contamination.

6.2.7 Residual impacts

It is considered that the identified pollutant linkages will be minimised to an acceptable level by the development proposals.

Residual impact after mitigation; Minor Positive

6.3 Sediment Quality

This section of the ESIA report describes the baseline sediment quality of the Khor Al-Zubair. Sediment is defined as the soils that have formed below the high water mark as a result of settlement and sedimentation from the water column. These sediments are either periodically (twice daily) wetted by the tide (in the intertidal zone) or permanently submerged in the river.

6.3.1 Assessment Methodology

Baseline Conditions

This study involved a combination of desk-based study, consultation with stakeholders and regulators, sediment sampling and testing, and associated analysis and risk assessment.

In order to determine the sediment quality, five sediment samples were collected from the Khor Al-Zubair riverbed in the Terminal development area (in addition to those samples collected for the ecological survey described in *Chapter 8*).

For collecting the sediment samples, a Van Veen Sediment Sampler was utilised. A Van Veen is a clamshell-shaped sampler which is lowered through the water column on a cable to the sediment surface. Upon reaching the river bed, the slack in the winch line causes the locking mechanism to release, allowing the sampler to close under its own weight, thereby, collecting a sample of sediment. The sampler was then pulled out of the water and returned to the vessel deck, where it was opened by hand and sediment was allowed to drop onto a clean plastic lining and placed in appropriate glassware. Two 'grabs' were completed at each sample location to provide a representative sample of the river bed at each location. Depth to riverbed will be noted using an echo sounder. The sampling was undertaken using a locally chartered vessel which had been audited and pre-approved by EAME.

During the sampling of the channel bed sediments, the condition, colour, odour and temperature of each sample was noted and recorded. The sediment was logged in accordance with accepted international logging nomenclature and the soil colour was determined in the field using the Munsell Colour Chart system.

All collected samples were collected in pre-cleaned sample jars of appropriate size and type for each laboratory analysis to be performed. All samples were given a unique reference number, dated and the information recorded on an appropriate Chain of Custody form for dispatch with the samples to the laboratory.

Photograph 6.6: *Van Veen Sediment Sampler*

Assessment Criteria

The chemical analysis results for sediment have been compared, where available, to the following standards:

- World Health Organisation (WHO) standards; and
- North American (US and Canadian) guideline values.

Whilst these guidelines are not directly applicable, they do provide a useful indicator value in the absence of Iraqi promulgated standards.

Identification of Impacts

The following effects are anticipated to occur from the construction and operational phases of the proposed development:

- the potential movement and dispersion of material in the various media during the construction phase from earthmoving and general construction works;
- potential for piling and dewatering of excavations to enable cross contamination of the ground strata; and

- mobilisation of contaminants and leaching through the sub strata to impact identified controlled waters, such as surface watercourses and groundwater bodies by the creation of new pathways.

Assessment and Evaluation of Effects

The assessment of effects has involved the following general approach:

- the identification and assessment of potential sources, pathways and receptors in relation to the proposed end use of the site during and following development;
- the sensitivity of receptors has been established on the basis of their use, proximity to the site, existing quality or resource value and consideration of potential pathways;
- the potential effects have been classified, prior to mitigation, as minor, moderate or major (either positive or negative); and
- where the predicted effects are considered to be significant, mitigation measures have been incorporated to eliminate or reduce the impacts to an acceptable level. The residual effects (post mitigation) are discussed in the final subsection of this chapter.

6.3.2 Baseline Conditions – Desk-based Research

In 2012, EAME undertook an environmental survey of the Khor Al-Zubair, relating to the rehabilitation of KZP, which included the collection of marine water and sediment samples from within the channel. The principal findings of the study were:

- There is generally a lack of evidence of significant pollution in the water, sediment and soils that were tested;
- The concentrations of target analytes, for both the sediment and water samples, were generally less than those observed during a previous study undertaken in 2009. However, this was deemed attributable to different laboratory techniques and large scale water and sediment transportation creating a different environment over time, rather than a notable improvement in water quality *per se*; and
- The levels of contaminants observed are not a significant cause for concern and should not prove to be an impediment to the dredging and disposal operations.

The JICA SAPROF report[16] indicated that over 200 sediment samples have been taken from forty locations within the Khor Al-Zubair channel; this includes thirty-five wrecks sites and five mid-channel sites. When compared to North American Guideline values, acceptable levels of sediment contamination have been noted:

- Heavy metal concentrations predominantly fall within North American guidelines, with relatively high levels of chromium, nickel and some other metals were attributed to high natural concentrations in the sediment;
- Uranium concentrations were also consistent with the crustal abundance;
- Hydrocarbon pollution was evident at a number of wreck sites distributed throughout project waters;
- Two samples submitted for PAHs analysis reported concentrations that exceeded North American guideline value; and
- There is no evidence of pollution from chlorinated pesticides and Polychlorinated Biphenyls (PCBs).

6.3.3 Baseline Conditions – Field Sampling

Sampling Locations

The sediment samples were obtained from positions adjacent to the proposed Terminal development area.

[16] Final Report For Special Assistance for Project Formation (SAPROF) on Port sector Rehabilitation Project in the Republic of Iraq, Japan Bank for International Cooperation (JBIC), 2005

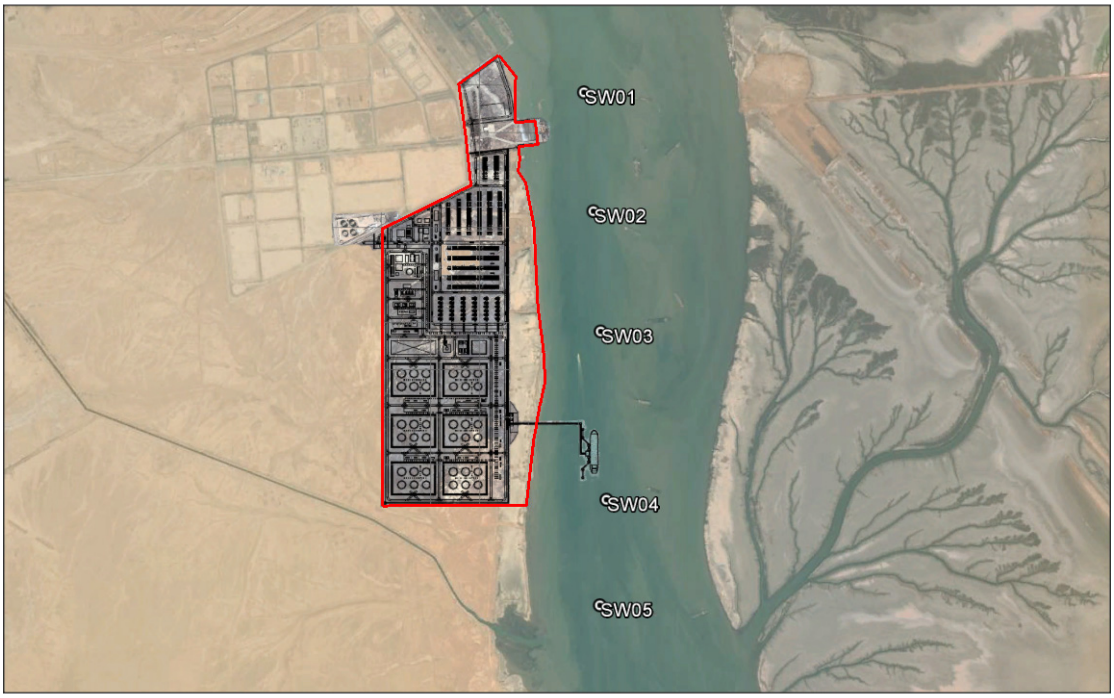

Figure 6.3: *Sediment sample locations*

Google Earth Pro Imaging with the permission of Google Licensed to Earth and Marine Environmental Consultants Ltd

Table 6.13: Sediment Sampling Locations

Location ID	Grid Reference	Depth to Sea Bed (m)	Meteorological Information	Sea State
SW01	30°10'58.12"N, 47°53'45.18"E	13.7	Sunny, windy	Choppy, 0.5m waves
SW02	30°10'41.95"N, 47°53'46.66"E	14.3	Sunny, windy	Choppy, 0.5m waves
SW03	30°10'25.60"N, 47°53'47.81"E	16.1	Sunny, windy	Choppy, 0.5m waves
SW04	30°10'2.73"N, 47°53'48.72"E	11.00	Sunny, windy	Choppy, 0.5m waves
SW05	30° 9'48.38"N, 47°53'47.68"E	12.00	Sunny, windy	Choppy, 0.5m waves

The river condition during the sampling was choppy with 0.5m waves as a result of the strong summer *Shamal* winds which are typical of this time of the year.

Field Observations and Measurements

The sediment samples were obtained on the 13th September 2014 using a Van Veen Sediment Sampler on a vessel which had been audited and pre-approved by EAME.

Table 6.14: Sediment Sampling - Field Observations and Measurements			
Location ID	**Description**	**Temp. (°C)**	**Munsell Colour Chart**
SW01	Grey-brown fine GRAVEL	27.5	10YR 7/3 Very pale brown
SW02	Grey – brown coarse SAND with numerous shells	26.3	5Y 6/2 Light olive gray
SW03	Grey – brown silty CLAY	31.6	10YR 6/2 Light brownish gray
SW04	Grey silty CLAY	28.4	10YR 7/1 Light gray
SW05	Grey silty CLAY	30.0	2.5YR 5/2 Brown

Analytical Strategy

The analytical strategy was designed by EAME to provide an assessment of the presence of a common range of potential contaminants.

Table 6.15: Analytical Strategy	
Parameter	**Rationale**
General Inorganics pH, Total Cyanide, Complex Cyanide, Free Cyanide, Total Sulphate as SO_4, Total Chloride, Water Soluble Phosphate as P (2:1), Total Nitrogen (Kjedahl), Total Organic Carbon (TOC)	General indicators of contamination
Total Phenols (Monohydric)	General indicator of contamination
Total Speciated PAHs	Speciated suite to determine the presence of fuel derivatives and associated compounds
Heavy Metals and Metalloids	General indicators of contamination
TPH (C_{10} – C_{40})	Targeted analysis for fuels and oils

Assessment of Analytical Results

EAME has undertaken a tiered approach in order to provide a preliminary qualitative assessment of the sediment analytical results. The first stage of assessment was to screen out those compounds that were not present above the method detection limit (MDL) of the laboratory. These are provided in the list below, and have thus not been considered further within the assessment.

- Cyanide (total, complex and free);
- Total phenols (monohydric);
- Total Speciated PAHs;
- Cadmium,
- Chromium (hexavalent);
- Mercury;
- Tin; and
- TPH (C_{10} – C_{40})

The remaining determinants that were detected above the laboratory MDL were then compared against a screening criteria value, where available. The samples were tested at an accredited UKAS laboratory (i2 Analytical), with the full analytical certificates presented in *Appendix G3* and summarised in *Table 6.16*.

Table 6.16: Summary of Sediment Analytical Results

Contaminant	Conc. Range (mg/kg)	Location of Sample with Max. Conc.	Screening Criteria (mg/kg)	No. of Exceedances of Screening Criteria
General Inorganics				
pH	7.5 – 8.0	SW02 and SW04	NG	-
Total Sulphate as SO_4	1,060 – 5,280	SW05	NG	-
Total Chloride	1,200 – 11,000	SW04	NG	-
Water Soluble Phosphate as P	<MDL – 0.12	SW05	NG	-

Table 6.16: Summary of Sediment Analytical Results

Contaminant	Conc. Range (mg/kg)	Location of Sample with Max. Conc.	Screening Criteria (mg/kg)	No. of Exceedances of Screening Criteria
(2:1)				
Total Nitrogen (Kjeldahl)	270 – 1,200	SW01	NG	-
TOC	0.2 – 0.7%	SW04 and SW05	NG	-
Heavy Metals and Metalloids				
Arsenic	3.0 – 4.3	SW01	5.9 [*1]	0
Copper	4.4 - 26	SW04	35.7 [*1]	0
Iron	4,800 – 34,000	SW04	NG	-
Lead	1.4 – 4.6	SW04	3.5 [*1]	**3 - SW03, SW04, SW05**
			91.3 [*2]	0
Manganese	100 - 400	SW04	NG	-
Nickel	8.6 – 89	SW04	NG	-
Zinc	11 – 41	SW04	123 [*1]	0

Notes:

Units are mg/kg except where indicated otherwise

NG = No Guideline available

<MDL = Below the Method Detection Limit

[*1] = Interim Sediment Quality Guidelines (ISQG) correspond to threshold level effects below which adverse biological effects are not expected.

[*2] = PEL – Probable Effect Level defines the level above which adverse effects are expected to occur frequently.

ISQG and PEL developed by Task Group of the Canadian Council of Ministers of the Environment (CCME).

Summary of Chemical Baseline Conditions (Sediment)

In summary, the only elevated parameter above its respective screening criteria was lead. Lead is a naturally-occurring element that can be harmful to humans when ingested or inhaled. For hundreds of years, lead has been mined, smelted, refined, and used in products (*e.g.*, as an additive in paint, gasoline, leaded pipes, solder, crystal, and ceramics). According to the USEPA natural levels of lead in soil range between 50 – 400 parts per million (ppm)[17]. Mining, smelting, and refining activities have resulted in substantial increases in lead levels in the environment, especially near mining and smelting sites.

All samples were above the Canadian Interim Sediment Quality Guidelines below which adverse biological effects are not expected but the results were below the Probable Effect Level (PEL) above which adverse effects are expected to occur frequently. The level of contamination is considered to be moderate.

The only potential source of contamination identified relates to elevated lead concentrations identified at three locations. All other parameters were recorded at concentrations below the relevant screening criteria are not considered to be environmentally significant. Considering the results overall and previous studies, the contamination levels of the sediments is considered to be low as is their associated pollution potential.

6.3.4 Impact Assessment

Construction and Operational Activities

The following potential sources of pollution could be associated with the construction and operational phases of the proposed development have been identified.

Table 6.17: Potential Future Sources of Sediment Contamination at the Site

Construction Phase	Operational Phase
Spillages of polluting materials during construction activities (e.g. fuel spills during plant refuelling).	Poor housekeeping operations or the occurrence of spillages such as fuel and oil leaks
	Spillage during transfer of petroleum products from marine tankers to tanks

It should be noted, however, that the sediment in this channel is very mobile and the sediment beneath the jetty is likely to change over a relatively short period of time. The river is also strongly tidal. Consequently, minor spills and leaks are likely to be more of an issue for water quality and will remain entrained in the water column rather than interact with the sediments.

[17] http://www.epa.gov/superfund/lead/health.htm

It would take a major incident for a release to be of sufficient magnitude to interact with the sediments. Such large scale disaster incidents are dealt with in *Chapter 10 – Hazard Analysis and Risk Assessment*.

Closure and Decommissioning

When the proposed Terminal is closed and decommissioned (and possibly demolished), there may be impacts associated with this. The activities that would typically be involved in the closure and decommissioning of such a facility would be similar to those during construction, involving plant and machinery, earthworks, materials movement and management. Likewise, therefore, the impacts would be similar. It is unlikely that a site such as this would be returned to the status of the present undeveloped site. Whilst potentially polluting materials and valuable or recyclable infrastructure (for example, tanks, pipes, scrap metal, machinery, plant) will be removed, the major structures (concrete, berths, drainage systems, walls, fences, etc) would be unlikely to be removed. In all likelihood, the site would probably be re-used for alternative uses or redeveloped. As such the extent of the works and associated traffic and construction type activities (machinery, earthworks, etc) associated with closure of the facility, whilst similar in nature to the construction activities, are expected to be lesser in scale and duration, as would be the associated impact. It is considered, therefore, that the impact of closure and decommissioning activities upon the sediment environment will be negligible.

6.3.5 Mitigation

Construction Phase

Plant machinery will be properly maintained to reduce the risk of hydrocarbon contamination and will only be active when required. Construction materials will be stored, handled and managed with due regard to the sensitivity of the local aquatic environment, thus, the risk of accidental spillage or release will be minimised.

Furthermore, mitigation measures have been incorporated into a CEMP, which sets out measures for the control of site drainage, reducing the risk of accidental spillages and the storage and handling of materials.

Any liquids such as degreasers, oils, diesel, required as part of the construction works will be stored in above ground tanks and located on designated areas of hardstanding.

Operational Phase

Hydrocarbon contamination from the transfer from marine tanker to tankage is considered to be a potential source of contamination from the routine operation of the site. The proposed Terminal will utilise modern industry standard equipment, thereby, reducing the potential risk of contamination, particularly when compared to the existing facilities. Furthermore, once operational, the terminal will operate relevant response procedures which, if needed, will react to reduce the impact of any contamination.

6.3.6 Residual Impacts

It is considered that the identified pollutant linkages will be minimised to an acceptable level by the development proposals.

Residual impact after mitigation; Neutral

6.4 Waste Management

6.4.1 Introduction

Wastes are an inevitable aspect of any business activity and often waste disposal (especially solid wastes) can impact on the land. There will be three aspects to waste management associated with the development. Firstly, wastes will be generated temporarily during the construction phase and secondly, once the site is developed and operational, there will be routine wastes associated with the activities of the proposed development, which will continue to be generated during the lifetime of the project. Finally during decommissioning of the closed facility wastes may once again be generated temporarily.

This section of the chapter considers the proposed development and how the waste characteristics of the current site use (and how they impact on the environment) may be altered by future waste generation activities associated with the development proposals.

6.4.2 Assessment Methodology and Significance Criteria

The waste management evaluation has considered the wastes that are likely to be generated as a result of the present site usage and the likely future construction and site operational wastes based on similar scale construction projects and operations.

The potential effects have been classified, prior to mitigation, as minor, moderate or major (either “Adverse”, “Beneficial” or “Neutral”). Where the predicted effects are considered to be significant, mitigation measures have been incorporated to eliminate or reduce the impacts to an acceptable level.

6.4.3 Legislation

Chapter V of Public Health Act (Law No. 89, 1981) sets specifications for healthy burial of waste. This chapter indicates five fundamentals concerning determination of site selection, methods of burial, machinery required, staff involved and other requirements. This, however, relates to dedicated sites for waste disposal (landfill) rather than waste producing sites. There is no specific legislation targeted at waste production from industrial and commercial sources.

6.4.4 Baseline Data

The following pertinent information was derived from the ESIA fieldworks undertaken in August and September 2014.

The northern elevation of the site comprises KAZ Jetty No. 1 and areas of unsurfaced land with areas utilised for the storage of scrap metal, much of which appears to be marine-derived (wreck salvage). However, the majority of the site, approximately 95%, is undeveloped. During the site walkover, fragments of suspected asbestos sheeting was noted within the area of the scrap metal storage. The intertidal zone is littered with domestic waste deposited by the river as well as large metal objects such as shipwrecks and redundant pipework.

Consequently, the site presently houses a large amount of scrap metal waste from the ship-breaking that has been taking place on the Khor Al-Zubair, however, this waste can be considered as historic. There are no waste generating activities on the site at present. The tide also washes a certain amount of waste and debris onto the shoreline. None of these wastes are managed in a controlled way and could be regarded as uncontrolled tipping.

6.4.5 Identification and Evaluation of Key Effects

For the proposed development site, the anticipated waste types that are predicted for both the construction and operational phases are presented in *Table 6.18*.

Table 6.18: Construction and Operational Phase Predicted Waste Types

Predicted Construction Phase Wastes	Predicted Operational Phase Wastes
Building demolition rubble comprising brick, glass, timber and concrete	Small quantities of waste oils and chemicals from site support activities
Asbestos containing materials (noted on-site)	Paper, cardboard and plastic packaging wastes
Excavated soil associated with foundation excavation and trenching for services	Soils and possible contamination from minor earthworks (sewer repair, trenching, post boring, *etc*)
Spoil from piling operations (if required)	Scrap metal and redundant plant and equipment
Waste oils, chemicals and potentially hazardous materials from buildings clearance	Waste vegetation from routine maintenance of landscaped areas (if present)
Scrap metal from the shipwrecks and redundant pipework located on-site	Construction/demolition wastes from periodic contractor activities
Vegetation from site stripping (if required)	Sanitary effluent
Waste paper, plastic, cardboard and wood from delivery of construction material and site activities during the works	Wastes deposited along the intertidal zone

Table 6.18: Construction and Operational Phase Predicted Waste Types	
Predicted Construction Phase Wastes	**Predicted Operational Phase Wastes**
Redundant unused construction materials	
Collected groundwater and rainwater	
Wastes deposited along the intertidal zone	

The volume of the wastes that will be generated cannot be specified at this time. It is possible, however, to give a relative assessment of the potential waste quantities and their intended fate (*Table 6.19*).

Table 6.19: Fate of Generated Wastes			
Waste Type	**Phase**	**Relative Volume**	**Fate**
Building demolition rubble comprising brick, glass, timber and concrete	Construction	Small to Moderate	Mixture of on-site re-use of materials and off-site recycling or disposal of unsuitable materials.
Asbestos containing material (noted on-site)	Construction	Small	Specialist removal by an appropriate contractor.
Excavated soil	Construction	Small	On-site reuse and re-profiling. Off-site disposal for materials that cannot be managed on-site effectively.
Redundant construction materials	Construction	Small	Return to supplier, recycling, sale or disposal.
Collected perched groundwater and rainwater	Construction	Small	Discharge to site surface or drainage system under controlled conditions if suitable or off-site treatment.

Table 6.19: Fate of Generated Wastes

Waste Type	Phase	Relative Volume	Fate
Trade effluent from vehicle wheel washing	Construction	Small	Discharge to site surface or drainage system under controlled conditions if suitable or off-site treatment.
Waste paper, plastic, cardboard and wood	Construction	Small to moderate	Off-site recycling and disposal via contracted waste management firm.
Waste oils, chemicals and potentially hazardous materials	Construction and operational	Small	Removal to appropriate treatment and disposal facilities.
Scrap metal and redundant plant and equipment	Construction and operational	Small	Off-site recycling.
Vegetation from site stripping	Construction and operational	Small	Off-site recycling or composting.
Sanitary waste water	Construction and operational	Small	Treatment by onsite Effluent Treatment Plant
General waste; paper, plastic, cardboard, food waste etc.	Operational	Small	Removal to appropriate disposal facilities.
Construction wastes from periodic contractor activities.	Operational	Small	Removal to appropriate disposal facilities.

Key:

Small = tens of tonnes

Moderate = hundreds of tonnes

Large = thousands of tonnes

Solid Waste Generation and Management – Construction Phase

Demolition rubble and excavated soils associated with the construction works will be the dominant and most environmental significant waste stream, however, it will be temporary in nature. Insofar as a summary of the management of wastes arising from the proposed development is concerned, the following aspects are pertinent:

- Any asbestos containing materials (ACMs) on-site will have to be removed and disposed of appropriately;
- Removal of scrap metal and shipwrecks from the site and intertidal zone;
- Removal of wastes deposited along the intertidal zone;
- All excavations will be monitored and analysed by qualified and experienced field scientists to ensure the chemical characteristics of the materials are understood and that they are handled and segregated appropriately;
- Arising from piling operations, if required, will be treated similarly to other excavated materials and will be appropriately monitored, analysed and managed;
- Detailed records (and where appropriate a photographic log) will be kept of all construction phase waste arisings and their management and fate; and
- All works will be undertaken with due attention to appropriate guidance.

Overall, the generation and management of solid waste associated with the construction phase is considered to have a ‘minor positive effect’, predominantly due to the removal of the asbestos sheeting, scrap metal and wastes deposited along the intertidal zone.

Solid Waste Generation and Management – Operational Phase

Once operational, the main solid waste stream will be general domestic waste from kitchens, offices and accommodation.

The overall solid waste generation and management operational phase effects are considered to be a ‘minor adverse effect’.

Waste Water Generation and Management

In addition to the aforementioned solid wastes, the proposed development will also generate waste waters. As with most aspects of the proposed development, the construction and operational phases need to be considered separately. These are discussed below.

Construction Phase

Waste waters likely to be generated on-site during the construction phase include the following:

- temporary septic tanks and/or portable toilets to be utilised by the construction workers;
- waste waters from dewatering of excavations (groundwater and surface water runoff);
- dirty water from the temporary on-site wheel wash (should one be required during the construction works);
- The dewatering of groundwater from excavations in any significant quantities is not anticipated to be required. However, any water arising from the dewatering of excavations will either be discharged back over the ground surface and allowed to infiltrate or discharged into the Khor Al-Zubair; and
- Waste water generated from the on-site wheel wash (if required) will be either be collected in a sealed system for reuse, or collected in a sealed system for authorised disposal.

Overall, the generation and management of waste water associated with the construction phase is considered to have a 'minor adverse effect' which will be temporary in nature.

Operational Phase

The main waste water stream once the site is operational will be sanitary wastewater from the toilet blocks, washrooms and catering facilities associated with the plant. It has been assumed that sanitary waste water will be treated by an on-site Effluent Treatment Plant.

Overall, the generation and management of waste water associated with the operational phase is considered to be 'neutral'.

6.4.6 Mitigation

The measures to be taken to manage solid wastes generated during the construction and operational phases are described previously. No additional mitigation measures are considered to be required.

The proposed development shall apply the waste hierarchy, as outlined below, where disposal is considered as the last choice.

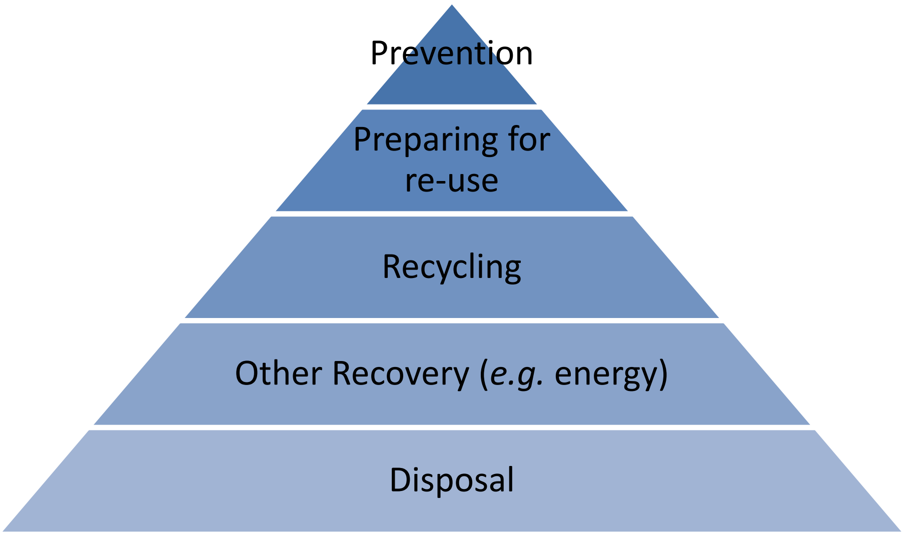

Figure 6.4: *Waste hierarchy*

A Site Waste Management Plan (SWMP) will be produced for the proposed development. The main objectives of which will to sure that all building materials are managed efficiently and that material recycling, re-use and recovery is maximised.

6.4.7 Residual Effects – Construction Phase

The effects arising from the construction phase are transient in nature and as such they are considered to have a 'neutral' residual effect.

6.4.8 Residual Effects – Operational Phase

Once operational, the main solid waste stream will be general domestic wastes from kitchens, offices and accommodation.

The main waste water stream once the site is operational will be sanitary wastewater from the toilet blocks, washrooms and catering facilities associated with the plant.

As such, the residual effect of the operational phase is considered to be 'neutral'.