



# City of Fremantle

## South Fremantle Landfill Site

### Interim Site Management Plan

April 2013



# Acronyms and Abbreviations

AHD	Australian Height Datum
BGL	Below Ground Level
CoT	Certificate of Title
CSM	Conceptual Site Model
DEC	Department of Environment and Conservation
DoH	Department of Health
DoW	Department of Water
DQIs	Data Quality Indicators
DQOs	Data Quality Objectives
DSI	Detailed Site Investigation
EMP	Environmental Management Plan
EIL	Ecological Investigation Level
HIL	Health Investigation Level
MoT	Memorial on Title
OH&S	Occupational Health and Safety
QA	Quality Assurance
QC	Quality Control
SAP	Sampling and Analysis Plan
RVP	Remediation and Validation Plan
I-SMP	Interim Site Management Plan

# Executive Summary

The City of Fremantle commissioned GHD to prepare an 'Interim' stage Site Management Plan for the South Fremantle Landfill Site (SFLS – referred to as 'the Site') to allow the City to continue to meet its obligations in regard to addressing contamination issues posed by the Site. The Site location is shown in Figure 1. DEC Site Summary Forms are included in Appendix A. This report presents the 'Interim' Site Management Plan (I-SMP) that has been prepared for the Site. This report is subject to, and must be read in conjunction with the limitations set out in Section 1.4 and the assumptions and qualifications contained throughout the report.

## **Background**

GHD has previously undertaken a Detailed Site Review (DSR, GHD 2011) which has assessed a substantial body of previous investigation information for the Site and identified a number of remaining data gaps concerning contamination risks posed by the Site.' Interim' actions were therefore proposed in the DSR to provide additional information required to address the remaining data gaps, clarify risks to relevant receptors and to allow development of a 'Final' Site Management Plan (F-SMP) for implementation of relevant remediation/other risk management measures.

The data gaps identified and corresponding actions recommended in the DSR with respect to current undeveloped open space 'use' were as follows:

- Sources of contamination associated with the Site;
- Pathways that may exist to allow the above sources to impact relevant receptors;
- Local background groundwater quality characteristics (including possible diffuse contamination from other up gradient anthropogenic sources unrelated to the Site);

Additional interim actions were also identified that should be implemented should redevelopment of the Site be contemplated. Of the data gaps identified, the following were considered in the DSR to be the highest priority for action due to the implications for resultant risks that may be posed to relevant receptors:

- Uncertainties concerning the extent of landfill, and potential for gases and/or vapours to migrate from the Daly Street area of the Site and impact existing adjacent residents/site users, are considered to be the highest priority for action (GV1, also GC5);
- Seek further clarification on disposal of quarantine waste from AQIS to ensure that there is no residual knowledge of this matter remaining within its corporate memory due to the constraint this imposes on future actions (GC1);
- Confirmation of gas generation potential, vapour species and impact of future development on gas regime (GV3, GV4, GV5);
- Off-site groundwater impacts appear to be of limited magnitude only and require confirmation (GW1-5, GW7);
- Other data gaps as identified in the DSR.

### ***Objectives and Scope of Work***

The aim of the I-SMP is to set out a programme for required interim actions to address identified data gaps assuming the Site use remains in its current undeveloped form. The programme is presented as a staged approach. I-SMP actions to address the identified data gaps are expected to allow management of the Site to proceed to the 'Final' Site Management Plan stage in which selection and/or design of remediation (and/or other risk management measures) will take place for subsequent implementation as part of a staged approach to management of contamination. Although not proposed at this time, the I-SMP also aims to document additional actions to be implemented should redevelopment of the Site be contemplated.

The specific objectives of the I-SMP scope of work are to:

- Present a formal management plan document presenting the previously identified DSR interim actions as a prioritised schedule of actions/works;
- Present an indicative programme for implementation of interim actions (GHD 2011);
- Submit the I-SMP to the Department of Environment and Conservation (DEC) Accredited Contaminated Site Auditor, Mr Jason Clay of AECOM for to allow subsequent implementation (as a separate scope/scopes of work).

It should be noted that the I-SMP is not intended to provide a Sampling and Analysis Plan or other detailed specification for proposed interim actions to address data gaps. Where relevant, these will be developed separately as an integral part of the proposed scope of work for the relevant interim actions.

Preliminary cost estimates for relevant interim actions for use by City of Fremantle for budgeting purposes are also included in the current scope of work. These are to be provided separately to City of Fremantle and are not included in this report.

### ***Conclusions and Recommendations***

GHD is of the opinion that the actions set out in this I-SMP will allow current data gaps to be addressed such that a 'Final' SMP can be prepared for implementation to manage risks to relevant receptors with respect to current undeveloped 'use'.

# Table of contents

1.	Introduction .....	1
1.1	Background .....	1
1.2	Interim Site Management Plan (I-SMP).....	0
1.3	Objectives and Scope of Work.....	0
1.4	Limitations .....	0
2.	Site Identification.....	3
2.1	Legal Identification .....	3
2.2	Site Description .....	4
2.3	Surrounding Land Use.....	4
2.4	Geology .....	4
2.5	Hydrogeology .....	5
2.6	Site History.....	5
2.7	Contamination Status .....	6
3.	Conceptual Site Model .....	8
4.	Data Quality Objectives.....	10
4.1	Step 1: State the Problem.....	10
4.2	Step 2: Identify the decisions .....	10
4.3	Step 3: Identify Inputs to the Decisions .....	11
4.4	Step 4: Define the Study Boundaries .....	11
4.5	Step 5: Develop a Decision Rule .....	11
4.6	Step 6: Specify Limits on Decision Errors .....	11
4.7	Step 7: Optimise the Design for Obtaining Data .....	11
5.	Data Gaps and Interim Actions.....	12
5.1	Data Gaps.....	12
5.2	Ground Conditions .....	13
5.3	Groundwater .....	14
5.4	Ground Gases and Vapours .....	17
5.5	Priority.....	19
6.	Interim Site Management Plan Strategy.....	20
6.1	Roles and Responsibilities.....	20
6.2	Aim and Objectives .....	20
6.3	Overview and Scope .....	21
6.4	'Final' Remediation or Site Management Plan.....	25
6.5	Possible further interim actions should redevelopment for a more sensitive use be contemplated.....	27
6.6	Proposed Timeline .....	29
7.	Community Consultation .....	30
8.	Conclusions and Recommendations.....	31

9. References .....	32
---------------------	----

## Table index

Table 1	Site Identification Details .....	3
Table 2	Legal Identification Details.....	3
Table 3	Conceptual Site Model .....	8
Table 4	Ground Conditions: Data Gaps.....	13
Table 5	Groundwater: Data Gaps.....	14
Table 6	Ground Gases and Vapours: Data Gaps.....	17
Table 7	Preliminary Order of Priority for Identified Actions (Site in current use).....	19
Table 8	Preliminary Order of Priority for Additional Identified Actions (if contemplating Site Redevelopment).....	19
Table 9	Interim Site Management Plan – Interim actions to address data gaps.....	22
Table 10	Anticipated ‘final’ Remediation and Validation or Site Management Actions .....	26
Table 11	Interim Site Management Plan – Possible further interim actions (redevelopment for more sensitive use) .....	28

## Figure index

Figure 1	Site Location
----------	---------------

## Appendices

Appendix A

DEC Site Summary Form

Appendix B

South Fremantle Landfill Site Environmental Management Plan – Interim. City of Fremantle 2004.

Appendix C

Proposed Timeline – Interim Actions





# 1. Introduction

The City of Fremantle commissioned GHD to prepare an 'Interim' stage Site Management Plan for the South Fremantle Landfill Site (SFLS – referred to as 'the Site') to allow the City to continue to meet its obligations in regard to addressing contamination issues posed by the Site. The Site location is shown in Figure 1. DEC Site Summary Forms are included in Appendix A. This report presents the 'Interim' Site Management Plan (I-SMP) that has been prepared for the Site. This report is subject to, and must be read in conjunction with the limitations set out in Section 1.4 and the assumptions and qualifications contained throughout the report.

## 1.1 Background

GHD has previously undertaken a Detailed Site Review (DSR, GHD 2011) which has assessed a substantial body of previous investigation information for the Site and identified a number of remaining data gaps concerning contamination risks posed by the Site.' Interim' actions were therefore proposed in the DSR to provide additional information required to address the remaining data gaps, clarify risks to relevant receptors and to allow development of a 'Final' Site Management Plan (F-SMP) for implementation of relevant remediation/other risk management measures.

The data gaps identified and corresponding actions recommended in the DSR with respect to current undeveloped open space 'use' were as follows:

- Sources of contamination associated with the Site;
- Pathways that may exist to allow the above sources to impact relevant receptors;
- Local background groundwater quality characteristics (including possible diffuse contamination from other up gradient anthropogenic sources unrelated to the Site);

Additional interim actions were also identified that should be implemented should redevelopment of the Site be contemplated. Of the data gaps identified, the following were considered in the DSR to be the highest priority for action due to the implications for resultant risks that may be posed to relevant receptors:

- Uncertainties concerning the extent of landfill, and potential for gases and/or vapours to migrate from the Daly Street area of the Site and impact existing adjacent residents/site users, are considered to be the highest priority for action (GV1, also GC5);
- Seek further clarification on disposal of quarantine waste from AQIS to ensure that there is no residual knowledge of this matter remaining within its corporate memory due to the constraint this imposes on future actions (GC1);
- Confirmation of gas generation potential, vapour species and impact of future development on gas regime (GV3, GV4, GV5);
- Off-site groundwater impacts appear to be of limited magnitude only and require confirmation (GW1-5, GW7);
- Other data gaps as identified in the DSR.

## 1.2 Interim Site Management Plan (I-SMP)

This report presents the 'Interim' Site Management Plan (I-SMP) that has been prepared for the Site. The Site location is shown in Figure 1. DEC Site Summary Forms are included in Appendix A. This report is subject to, and must be read in conjunction with the limitations set out in Section 1.4 and the assumptions and qualifications contained throughout the report.

## 1.3 Objectives and Scope of Work

The aim of the I-SMP is to set out a programme for required interim actions to address identified data gaps that will be implemented in a staged approach at the Site assuming this remains in its current undeveloped form. I-SMP actions to address the identified data gaps are expected to allow management of the Site to proceed to the 'Final' Site Management Plan stage in which selection and/or design of remediation (and/or other risk management measures) will take place for subsequent implementation as part of a staged approach to management of contamination. Although not proposed at this time, the I-SMP also aims to document additional actions to be implemented should redevelopment of the Site be contemplated.

The specific objectives of the I-SMP scope of work are to:

- Present a formal management plan document presenting the previously identified DSR actions as a prioritised schedule of actions/works;
- Present an indicative programme for implementation of DSR actions;
- Prepare preliminary cost estimates for DSR actions for use by City of Fremantle for budgeting purposes (provided separately);
- Submit the I-SMP to the Department of Environment and Conservation (DEC) Accredited Contaminated Site Auditor, Mr Jason Clay of AECOM for endorsement of the prioritised schedule of actions to allow subsequent implementation (as a separate scope/scopes of work).

## 1.4 Limitations

This Interim Site Management Plan for South Fremantle Landfill Site ("Report"):

- has been prepared by GHD Pty Ltd ("GHD") for the City of Fremantle;
- may only be used and relied on by City of Fremantle, the Department of Environment and Conservation ("DEC") and the appointed Contaminated Sites Auditor Mr Jason Clay of AECOM;
- must not be copied to, used by, or relied on by any person other than the City of Fremantle, DEC and the appointed Contaminated Sites Auditor Mr Jason Clay of AECOM without the prior written consent of GHD;
- may only be used for the purpose of improving conceptual understanding of the Site via the Conceptual Site Model (CSM) and identified data gaps to assist in taking the Site forward to a conclusion (and must not be used for any other purpose).

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than City of Fremantle arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report:

- were limited to those specifically detailed in section 1.3 of this Report;
- did not include site visits or intrusive investigations, sampling or laboratory testing.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report (“Assumptions”), including (but not limited to):

- Disposal of quarantine waste at the Site (or not) has not been conclusively determined from available information. AQIS information has not been directly reviewed for the Site, its records are not currently available and information relating to possible disposal is therefore assumed to be anecdotal in nature.
- Interim management measures already identified by others are assumed to be in place and be effective, including:
  - The air quality management plan recommended by Aquaterra (2006)
  - Restrictions on down gradient use of groundwater (Aquaterra 2006) In particular:
    - Bore water not to be used as drinking water;
    - Irrigated home grown produce should be washed with drinking water before eating.
    - Fremantle Village gas management plan has been implemented, is appropriate and effective.
  - Other relevant management measures set out in the South Fremantle Landfill Site Environmental Management Plan - Interim (City of Fremantle August 2004).
- Properties in the vicinity of the Site have conventional slab on ground foundations and do not have structures likely to be capable of enhanced opportunity for accumulation of ground gases/vapours (e.g. basements)

The preliminary cost estimate (“Cost Estimate”) has been prepared by GHD for City of Fremantle and may only be used and relied on by City of Fremantle for the purpose agreed between GHD and the City of Fremantle. The Cost Estimate has been prepared for City of Fremantle’s preliminary budgeting purposes and must not be used for any other purpose. GHD otherwise disclaims responsibility to any person other than City of Fremantle arising in connection with this Cost Estimate. GHD also excludes implied warranties and conditions, to the extent legally permissible. GHD has prepared the Cost Estimate using information reasonably available to the GHD employee(s) who prepared this Cost Estimate; and based on assumptions and judgments made by GHD. In particular assumptions have been made concerning the scope of the interim actions that will need to be undertaken and timescales for implementation (which are where possible based on indicative rates from third parties and/or similar work on other projects or published cost indices). Consideration of contingencies for some aspects of possible additional work that may be required has also been included in this Cost Estimate which are based upon a range of assumptions concerning the nature and possible extent of contamination issues that need to be addressed. The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the project can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile. All costs are exclusive of GST and based upon pricing information as at March 2013. No escalation of costs for work carried out after this date has been allowed.

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on until 30<sup>th</sup> September 2013, after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

## 2. Site Identification

Previous reporting (Detailed Site Review, GHD 2011) presents detailed information concerning site identification, history, conditions and the surrounding environment for the Site. A brief summary only of Site characteristics are presented below. Reference should be made to the above report and relevant other previous reporting for further information, including historical Certificates of Title (CoT), historical and surrounding land uses and historical aerial photographs.

### 2.1 Legal Identification

The legal identification of the Site is reported in Table 1 and Table 2. The DEC Site Summary Form is enclosed in Appendix A. A locality plan showing the Site, in the context of its surrounds, is provided as Figure 1.

**Table 1 Site Identification Details**

Site Identification Details	
Common Name of Site	South Fremantle Landfill Site
Local Government Authority	City of Fremantle
Coordinates of the Site Boundary <sup>1</sup>	North-West Corner Zone: 50 Northing: 6450686 Easting: 382720 South-East Corner Zone: 50 Northing: 6450002 Easting: 383077

<sup>1</sup> Coordinates are provided in MGA94.

The Site is currently split across a number of legal identification areas, the details of which are summarised in Table 2.

**Table 2 Legal Identification Details**

Street Address	Description	Certificate of Title (Volume-Folio)
Lot 38 on diagram 20161	1192-393	38 Daly Street, South Fremantle WA 6162
Lot 12 on plan 122	1105-195	32 Daly Street, South Fremantle WA 6162
Lot 9 on plan 122	669-45	34 Daly Street, South Fremantle WA 6162
Lot 8 on plan 122	752-76	36 Daly Street, South Fremantle WA 6162
Lot 39 on diagram 20161	1192-391	39 Daly Street, South Fremantle WA 6162
Lot 203 on plan 245466	1834-964	203 Daly St, South Fremantle WA 6162
Lots 39 to 58 on plan 2019		39 to 58 Island St, South Fremantle WA 6162
Lots 32 to 34 on plan 2019	1834-964	South Fremantle WA 6162
Lots 25 to 31 on plan 2019	1834-964	25 to 31 Ocean Road, South Fremantle WA 6162

Street Address	Description	Certificate of Title (Volume-Folio)
Lot 9010 on plan 50631		30 Keeling Way, South Fremantle WA 6162
Lot 1728 On plan 159082	1272-897	1728 Ocean Road, South Fremantle WA 6162
Lot 51 on plan 7217		South Fremantle WA 6162
Lot 153 on plan 7217		South Fremantle WA 6162
Lot 10 on diagram 2492	1226-104	10 Island Street, South Fremantle WA 6162
Lot 9 on diagram 2492	1226-104	9 Island Street, South Fremantle WA 6162
Lot 8 on diagram 2492	1226-104	8 Island Street, South Fremantle WA 6162
Lot 7 on diagram 2492	1226-104	7 Island Street, South Fremantle WA 6162
Lot 52 on plan 7217		South Fremantle WA 6162
Lot 152 on plan 7217		South Fremantle WA 6162
Lot 1 on plan 2513	1745-017	1 Cockburn Rd South Fremantle WA 6162

## 2.2 Site Description

The Site is situated on 19.4 ha of land, approximately 18 km south-west of the Perth CBD. The Site is separated into three areas, which are commonly referred to as 'Daly Street', 'Hollis Park' and 'Sandown Park'.

The Site is not currently in formal use and has no infrastructure present with the exception of small drains leading to open soak well type structures at the southern boundary of Sandown Park. The Site is generally covered by grass/scrub vegetation with occasional clusters of trees near site boundaries. A footpath also crosses the site from west to east which is fenced to restrict access to surrounding parts of the Site (Appendix E). A large bunded area is also present on the Sandown Park area of the Site.

## 2.3 Surrounding Land Use

The surrounding land use is shown in Figure 1 and is described below.

- North:** The Site is bound to the north-east by residential properties to the north-west and commercial and industrial properties to the north-east.
- South:** The Site is bound to the south by the Fremantle Chalet Village
- East:** The Site is bound to the east by Hampton Road and Cockburn Road
- West:** The Site is bound to the west by former industrial land which is now being developed for residential purposes. The Indian Ocean is located approximately 300 m to the west of the Site.

## 2.4 Geology

Quarrying/sand extraction and landfill activity has significantly influenced the lithology of the Site. Natural strata comprises Safety Bay Sand over Tamala Limestone, however excavation

and subsequent landfilling has resulted in significant spatial variation in the occurrence of natural strata which is overlain by variable thicknesses of highly heterogeneous waste materials and surface fill capping (of variable thickness). Further complexity in the identification of strata at the site is added by the presence of fill materials which are similar in nature and composition to natural strata and were most likely locally won natural materials that were disposed of at the Site as surplus fill.

## 2.5 Hydrogeology

Natural strata underlying the Site forms part of the shallow unconfined Superficial Aquifer with a net regional groundwater flow direction to the west toward the Indian Ocean indicated by published information. Groundwater conditions are however appear more complex on a local scale due to influence from the heterogeneous fissured-porous nature of the aquifer (dual porosity, Tamala limestone) and local anthropogenic effects.

From review of available information, knowledge gained from assessment of other sites in the area and subject to the limitations of the dataset available previous assessment (GHD 2011) determined that:

- Groundwater is generally present within Tamala limestone deposits that underlie much of the site (and underlie the waste mass). The groundwater system, being limestone, is inferred to have the properties of dual porosity medium with flow being dominated by preferential pathways within the secondary porosity (i.e. fractures/fissures) rather than matrix (primary porosity) flow.
- Groundwater flow is to the west direction towards the Indian Ocean with a gentle hydraulic gradient. (i.e. less than 0.001). Variations due to local effects are however present and constrain interpretation based predominantly on on-site boreholes;
- Groundwater fluctuates seasonally between levels slightly above or below the base of infilled excavations.

## 2.6 Site History

The sequence of landfill development determined from previous assessment (GHD 2011) is summarised below:

- Early quarrying/sand extraction activities in the Daly Street area prior to 1930 and Sandown Park area prior to 1956/57;
- Daly Street: waste disposal activity from 1931-1956/57 (and resumed from closure of Sandown Park to 1991). In addition, the extent of quarrying and possibly subsequent landfilling may have extended beyond the northern and eastern boundaries of the Daly Street area;
- Hollis Park: waste disposal activity from 1931-1956/57 (sullage pit disposal continued into the 1960's);
- Sandown Park: waste disposal from 1956/57 to 1980, then waste transfer station use to 1991.

## 2.7 Contamination Status

### 2.7.1 Soil

Previous investigations (see GHD 2011) reported of concentrations of substances to vary greatly over the Site, as would be expected for a highly heterogenous fill consisting of waste materials. In some instances these exceeded published screening assessment criteria (Ecological Investigation Levels - EIL, Health Investigation Levels - HIL A) with respect to metals, semi metals and total petroleum hydrocarbons. Due to the nature of materials at the Site, the presence of other contaminants at the Site cannot however be precluded.

### 2.7.2 Groundwater

With respect to groundwater contamination, review of available information (GHD 2011) indicated:

- On site impact to groundwater which broadly corresponds with the indicated extent of shallow and deep landfill activity (with the possible exception of Nitrate as N and chloride) and to the established overall groundwater flow direction;
- Significant variation in groundwater quality characteristics between monitoring wells on site (as would be expected for a highly heterogenous fill consisting of waste materials) and potentially indicative of localised rather than diffuse scale impacts for some substances (e.g. chloride, which it should be noted is a useful tracer species given its conservative behaviour in groundwater);
- The impacts recorded to date are of a relatively low order of magnitude compared to that which may be anticipated from the reported history and circumstances of the Site;
- Nitrate is likely to be entering groundwater from the Site, however, the pattern and extent of impact is unclear. Impacts may also be present from other urban sources in the locality and a regional/local background component, which are likely to contribute to the concentrations observed but are difficult to specifically identify;
- Petroleum hydrocarbons appear to be the most common form of non-aqueous phase liquids (NAPL) to be encountered within groundwater. However, available information does not indicate the likelihood of substances being present as a separate phase.

It was considered that the pattern evident from such data may be reflective of limited magnitude impacts to groundwater due to diffuse or localised sources at the Site that have relatively inefficient pathways to groundwater as a result of:

- Limited infiltration of surface waters (i.e. through flow) and resultant leachate generation associated with climatic conditions (i.e. low and seasonal rainfall).
- Limited direct contact of waste materials with groundwater (groundwater is slightly below or above the base of the deeper waste masses at Daly Street and Sandown Park due to seasonal variation).

However, whilst groundwater impact appears to be of limited magnitude based on available data, GHD 2011 advised that some uncertainty remains as there does not appear to be sufficient data to conclusively support this apparent trend as being definitive. A number of primary and secondary contaminants of concern and possible other substances of interest were therefore identified.



### 2.7.3 Ground Gases and Vapours

GHD 2011 stated that overall, the gas regime indicated biological and/or chemical degradation processes to be occurring within the waste mass at the Daly Street (predominantly aerobic) and Sandown Park areas of the Site (anaerobic) and to be reasonably consistent with the history of landfill development at the Site. The corresponding lack of detected gases at the Hollis Park area was also considered to be consistent with the history of waste disposal (i.e. limited) at that area of the Site.

Degradation processes did not appear to be inhibited by the presence of any chemical wastes that may have also been deposited at the Site, however, GHD 2011 stated that if the future moisture content of the wastes is lower than historically has been the case, generation rates may be lower with a longer overall time period taken for degradation to decline to residual levels.

Based on available information, GHD 2011 considered that migration of methane in groundwater was generally unlikely to occur given the unconfined nature of the groundwater and the very permeable strata at the site and adjacent sites. However, data concerning methane and carbon dioxide concentrations in groundwater was stated to be required to confirm this.

Derivation of Gas Screening Values (GSV) based on data from the site, for comparison with generic criteria presented in Ciria C665 (Ciria, 2007) with respect to hazards from ground gases and vapours indicated the following:

- Daly Street area: Characteristic Situation 2, i.e. 'low' risk (Ciria C665).
- Hollis Park area: Characteristic Situation 1, i.e. 'very low' risk (Ciria C665).
- Sandown Park area: Characteristic Situation 2, i.e. 'low' risk (Ciria C665).

Although GSVs for the Site indicated a relatively low level of risk associated with current Site conditions due to a lack of measured gas flow, areas of concern were identified to remain with respect to potential for off-site migration of ground gases and vapours at:

- Daly Street Area: Northern and Eastern boundary
- Daly Street Area: Western boundary
- Sandown Park Area: Southern boundary.

These were identified as the main areas of concern with respect to potential for off-site migration due to their particular circumstances, i.e.

- Elevated concentrations of gases and or/ vapours close to the site boundaries,
- Uncertainty concerning ground conditions beyond those boundaries (including the known or suspected continuation of the former landfill beyond the northern end of the Daly Street area and the southern boundary of Sandown Park);
- Close proximity of development beyond those boundaries.

The presence of elevated ground gases and vapours at the Site was also likely to be a significant hazard to future development at the Site as this would introduce additional pathways (e.g. vertical migration via deep foundations) and receptors (e.g. future site users) to the Site, as well as potentially enhance the viability of existing pathways such as greater lateral migration due to low permeability surfacing.

### 3. Conceptual Site Model

A Conceptual Site Model (CSM) was developed from the review of available information describing potential sources of contamination, receptors and the pathways that may exist between them with respect to:

- Current undeveloped 'use';
- Possible future redevelopment (as set out in a conceptual development proposal developed by the South Fremantle Landfill Site Stakeholder Advisory Group - SFLSSAG, as set out in Appendix D of the Detailed Site Review, GHS 2011).

Sources, pathways and receptors identified from the DSR review are summarised below:

**Table 3 Conceptual Site Model**

Sources	Pathways	Receptors
<p>Inorganic and organic substances and pathogens within waste/fill materials;</p> <p>Mobile contaminants within groundwater (primary and secondary groundwater contaminants of concern and possible other substances of interest.</p> <p>Ground gases and vapours.</p>	<p>Vertical migration of gases/vapours via permeable materials and surface emission.</p> <p>Lateral migration of gases/vapours via permeable strata fill/waste/ natural strata (or via groundwater)</p> <p>Vertical migration of gases/vapours to buildings and intrusion (asphyxiation and/or explosion hazard). Also accumulation within and migration via services (asphyxiation and/or explosion hazard).</p> <p>Direct contact with contaminants (in soil).</p> <p>Wind borne dust.</p> <p>Migration of mobile contaminants via groundwater abstraction bore (non-potable use).</p>	<p>Human health:</p> <p>Existing site visitors (fenced footpath)</p> <p>Existing maintenance workers</p> <p>Existing adjacent site users</p> <p>Future Site Users (public open space users, residents, commercial users)</p>
	<p>Direct contact with contaminants (in soil or groundwater).</p> <p>Wind borne dust.</p> <p>Lateral migration of dissolved contaminants via groundwater flow</p>	<p>Environment:</p> <p>Groundwater</p> <p>Indian Ocean</p> <p>Flora and Fauna (on site)</p> <p>Flora and Fauna (off site)</p>
	<p>Lateral migration of gases/vapours via permeable strata fill/waste/ natural strata.</p> <p>Vertical migration of gases/vapours to buildings and intrusion via cracks/construction joints and openings in concrete ground slab and accumulation in indoor air (explosion hazard). Also accumulation within and migration via services pipes/ducts/drains/bores (explosion hazard).</p> <p>Direct contact with contaminants (in soil).</p> <p>Irrigated vegetation contact with bore water.</p>	<p>Property:</p> <p>Existing on site below ground infrastructure (gas pipeline)</p> <p>Existing off site buildings and below ground infrastructure</p> <p>Future Site Uses (buildings, hard standing, below ground infrastructure, introduced vegetation/landscaping)</p>

The CSM (and likely risk to receptors arising from source-pathway-receptor relationships) is subject to uncertainty due to data gaps in available information which were identified in the DSR with respect to:

- Sources of contamination associated with the Site;
- Pathways that may exist to allow the above sources to impact relevant receptors;

- Local background groundwater quality characteristics (including possible diffuse contamination from other up gradient anthropogenic sources unrelated to the Site);
- Impacts from possible future development.

The data gaps (and relevant actions to address them) are considered further in the following sections of this report.

## 4. Data Quality Objectives

Development of Data Quality Objectives (DQOs) for the investigation is based on guidance presented in AS 4482.1 - 2005 and as further described in the document *Guidance for the Data Quality Objectives Process (EPA QA/G-4)* (US EPA, 2006).

The DQO process comprises seven steps which comprise:

- Step 1: State the Problem.
- Step 2: Identify the Decision.
- Step 3: Identify Inputs into the Decision.
- Step 4: Define the Study Boundaries.
- Step 5: Develop a Decision Rule.
- Step 6: Specify Limits on Decision Errors.
- Step 7: Optimise the Design for Obtaining Data.

Steps 1-4 and 7 of this process are considered relevant to the problem under consideration as set out below.

### 4.1 Step 1: State the Problem

The Site is contaminated as a result of previous use as a landfill. This is classified by the DEC as 'Contaminated – remediation required' with a restriction upon any use or occupation of the Site until appropriate remedial measures have been implemented such that potential risks to human health are not present. The problem is that:

- A number of data gaps exist concerning risks posed to relevant receptors which need to be addressed so that appropriate remedial measures can be specified and implemented;
- The data gaps have varying levels of complexity and priority;
- City of Fremantle has finite resources available to address the data gaps.

### 4.2 Step 2: Identify the decisions

Implementation of actions to address data gaps needs to be managed so that these:

- Are prioritised appropriately and implemented within a reasonable timescale with respect to both the finite resources available and regulatory requirements.
- Allow appropriate remedial measures to be specified and implemented.
- Do not adversely affect ongoing environmental management measures which have already been implemented (City of Fremantle 2004).

The decision to be made is therefore whether identified actions to address data gaps will be undertaken in an appropriate manner. The objective of this I-SMP is therefore to set out a prioritised programme for implementation of actions to address the identified data gaps that is acceptable to the Auditor and regulatory authority (the Department of Environment and Conservation – DEC).

### 4.3 Step 3: Identify Inputs to the Decisions

The I-SMP has been prepared to set out a programme for implementation of actions to address data gaps and prioritisation of City of Fremantle resources and allow the decision set out in Section 4.2 to be made. Inputs to the decision will comprise:

- The identified data gaps (and their prioritisation) – Section 6.2
- Programme for implementation of actions to address data gaps – Section 6.6.

### 4.4 Step 4: Define the Study Boundaries

The 'study boundaries' for the interim actions to address data gaps extend beyond the South Fremantle Landfill Site (as defined in Section 2.1) as the actions are required to assess offsite gas/vapour conditions and groundwater quality up and down gradient of the Site. The 'study boundaries' in broad terms extend to adjacent properties within approximately 500m of the South Fremantle and are defined in temporal terms by the duration of the interim actions set out in proposed programme. Outcomes of interim actions will be used to determine the extent of remedial measures that are ultimately required and their boundaries.

### 4.5 Step 5: Develop a Decision Rule

To be defined as part of implementation of relevant interim actions.

### 4.6 Step 6: Specify Limits on Decision Errors

To be defined as part of implementation of relevant interim actions.

### 4.7 Step 7: Optimise the Design for Obtaining Data

This will be achieved by implementing the identified interim actions which will be reviewed and refined as necessary during the programme of works by evaluating field observations and analytical results, where applicable.

# 5. Data Gaps and Interim Actions

## 5.1 Data Gaps

Based on the Conceptual Site Model (Section 3) the data gaps summarised below were identified in the DSR report (GHD 2011) along with their significance and actions proposed to be taken to address them. The identified data gaps are grouped under the following sub-headings for ease of reference:

- Ground Conditions (GC)
- Groundwater (GW)
- Gas and Vapour (GV)

## 5.2 Ground Conditions

Identified data gaps, significance and actions concerning ground conditions are presented below.

Table 4 Ground Conditions: Data Gaps

Data Gap	Details	Significance	Action
GC1 - Quarantine Waste	<p>Correspondence from the AQIS Cargo Management and Shipping Group suggests that they used the site for deep burial of quarantine waste (Aquaterra 2006). Aquaterra (2006) also states that AQIS subsequently advised the City of Fremantle that their records relating to disposals of quarantine waste at the Site are no longer available so the nature, volume, location and depth of the quarantine waste cannot be confirmed. Potential requirement for EPA referral for future work identified in previous assessment (Golder 2007).</p>	<p>Highly significant. Lack of knowledge concerning location and types of wastes disposed and precautionary measures likely to be required for earthworks/disturbance significantly constrains options for further investigation and remediation of the Site (including re-profiling such as removal of bund at Sandown Park area).</p>	<p>Due to constraints imposed by this data gap, seek further clarification on this matter from AQIS to ensure that there is no residual knowledge of this matter remaining within its corporate memory that may assist in addressing this constraint.</p> <p>Undertake risk assessment with respect to quarantine waste, future works and appropriate management measures for incorporation into Site Management Plan. Scope dependent upon outcome from above enquiry.</p>
GC2 - General contamination characteristics of waste/fills (and capping materials and bund materials at Sandown Park)	<p>Waste types broadly known in the Daly Street, Hollis Park and Sandown Park areas. However, due to highly heterogenous nature, the presence of other contaminants at the Site cannot be precluded. Uncertainty concerning diffuse or localised nature of sources remains.</p> <p>Air quality management plan (Aquaterra 2006) is assumed to be in place and effective.</p>	<p>Limited significance only (current use). Site is fenced and vegetated to restrict access to soil contaminants/dust. Broad range of contaminants has been previously assessed (groundwater), identified off site impacts appear to be of limited magnitude only. Near surface soil contamination characteristics are of greater significance for redevelopment and direct contact pathways.</p> <p>Ability to investigate and address significantly constrained by GC1.</p>	<p>Current use - no action unless circumstances vary from those identified in this assessment and/or integrity of existing capping is compromised (to an extent allowing exposure of relevant receptors to hazardous materials). Possible future use. Detailed site investigation (subject to GC1 constraint) required to:</p> <p>Further characterise soil contamination characteristics of capping/waste/fill materials.</p> <p>Assess risks to receptors introduced in future development.</p> <p>Determine requirements for intervention (i.e. remediation) and ongoing management for incorporation into Site Management Plan.</p>
GC3 - Stability characteristics	<p>Heterogenous waste/fill and buried excavation side slopes/high walls with a potential for excessive total and/differential settlements.</p> <p>Settlement effects observed at off-site commercial building and access road spanning apparent location of former quarry high wall north of Daly Street area.</p>	<p>Limited (current use). Site is fenced to restrict access. Existing gas pipeline assumed to be designed to accommodate range of total and/or differential settlements which may occur and subject to appropriate integrity checks.</p> <p>Significant (possible future development) due to requirement for densification/ground improvement and/or deep foundations which will create new pathways and increased potential for contaminant migration and potentially affect integrity of engineered control systems such as capping. Also potential long term maintenance/serviceability issues for treated areas depending upon degree of compaction achievable.</p>	<p>Current use - no action unless integrity of existing capping is compromised (to an extent allowing exposure of relevant receptors to hazardous materials). Possible future development. Detailed geotechnical Investigation (subject to GC1 constraint) required to:</p> <p>Determine stability characteristics of materials.</p> <p>Determine engineering solutions required to mitigate stability risks and permit construction of development structures (e.g. foundation types, ground improvement measures, engineered capping system, ongoing management).</p> <p>Determine viability of densification measures with respect to possible impacts upon existing sensitive structures (vibration etc) and potential for enhanced</p>

		Ability to investigate and address significantly constrained by GC1.	leachate migration. Determine suitability of underlying limestone strata for deep foundations. Assess potential aggressive ground conditions (detrimental effects upon buried structures) and protective measures. Develop (and implement) Site Management Plan.
GC4 - Possible munitions disposal	Anecdotal evidence of munitions disposal at Site (PPK 1998, Aquaterra 2006).	Limited (current use). Significant (possible future development) due to potential for disturbance in densification/ground improvement and/or deep foundations. Ability to investigate and address significantly constrained by GC1.	Current use - no action unless circumstances vary from those identified in this assessment allowing exposure of relevant receptors to hazardous materials. Possible future use. Adoption of appropriate precautions in future intrusive works to mitigate as far as possible risks from disturbing buried munitions for incorporation into Site Management Plan.
GC5 - Daly St landfill extent	Extent of former quarry and possibly landfill waste indicated to extend beyond current northern and eastern boundary onto adjacent land in commercial use. Waste also appears to extend up to western boundary.	Highly significant. Source and/or enhanced migration pathway may extend beyond the Site boundary.	Additional investigation (subject to GC1 constraint) at adjacent land to determine presence/absence and if present nature/extent of waste/fill. Assessment of risks to relevant receptors (based on findings from above). Development of Site Management Plan with respect to potentially unacceptable risks (if identified) from on-site sources.

### 5.3 Groundwater

Identified data gaps, significance and actions concerning groundwater are presented below.

Table 5 Groundwater: Data Gaps

Data Gap	Details	Significance	Action
GW1 - hydrogeological regime	Inconsistency in groundwater flow direction (WSP 2007) compared to earlier work. Limitations in earlier data related to uncertain groundwater elevations.	Significant - although considered to be due to limitations of the groundwater monitoring network available (network scale, number type and locations of installations).	Expand groundwater monitoring network beyond the Site and undertake appropriate period of groundwater level monitoring. In particular: Install up and down gradient monitoring installations. Confirm elevations and serviceability of all existing monitoring installations at/in vicinity of Site (to form part of expanded network). Seek permission of City of Cockburn to incorporate relevant bores known to have been installed at North Coogee foreshore (WSW/down gradient of Site).
GW2 - Background (up gradient) water quality	Local background water quality characteristics are not known including diffuse contamination from anthropogenic	Significant - concentrations of certain substances in groundwater (including nutrients, chloride, iron, copper, nickel, zinc) may partly originate from other urban	As for GW1 above and: Undertake appropriate period of groundwater monitoring for primary and secondary contaminants of



	activities.	sources in the locality and/or a further regional/local background component (from urbanised and horticulture areas).	concern and other relevant supporting water quality parameters. Limited sampling only for possible other substances of interest to be undertaken unless detected above relevant assessment criteria. Undertake assessment to determine local background water quality characteristics which do not originate from the Site.
GW3 - scale of groundwater impacts	Uncertainty exists concerning whether or not groundwater impacts are from diffuse or localised sources.	Significant - off site groundwater impacts appear to be of limited magnitude only. Ability to investigate further on site is significantly constrained by GC1 - can be mitigated by use of existing installations provided these are still serviceable.	As for GW1 above and: Undertake appropriate period of groundwater monitoring for groundwater primary and secondary contaminants of concern and other relevant supporting water quality parameters. Undertake assessment in context of expanded monitoring network to determine scale of impacts.
GW4 - down gradient groundwater quality characteristics	Down gradient groundwater quality characteristics are uncertain due to the limitations of the groundwater monitoring network available (network scale, number type and locations of installations). Possible other down gradient water quality influences may also exist (e.g. nearby reinjection bores for the Port Coogee Groundwater Interception Drain). Restrictions on down gradient use of groundwater (Aquaterra 2006) assumed to be in place, effective and in accordance with DEC (2011) advice. In particular: Bore water not to be used as drinking water. Irrigated home grown produce should be washed with drinking water before eating.	Significant - off site groundwater impacts appear to be of limited magnitude only and require confirmation.	As for GW1 above and: Undertake appropriate period of groundwater monitoring for groundwater primary and secondary contaminants of concern and other relevant supporting water quality parameters. Limited sampling only for possible other substances of interest to be undertaken unless detected above relevant assessment criteria. Undertake assessment to determine down gradient water quality characteristics which originate/do not originate from the Site. Determination of appropriate management measures/remediation for incorporation into Site Management Plan.
GW5 - groundwater impact upon marine water quality	Down gradient groundwater quality characteristics are uncertain due to the limitations of the groundwater monitoring network available (network scale, number type and locations of installations). Marine water quality impacts (if any) are unknown.	Significant - off site groundwater impacts appear to be of limited magnitude only and require confirmation.	As for GW1 above and: Down gradient monitoring installations to seek to target include likely zones of discharge to Indian Ocean (where practicable/feasible). Undertake appropriate period of groundwater monitoring for groundwater primary and secondary contaminants of concern and other relevant supporting water quality parameters. Undertake assessment to determine likely risks posed to Indian Ocean receptor. Determination of appropriate management measures/remediation for incorporation into Site

			Management Plan.
GW6 - groundwater impact from the Fremantle Village site	The Fremantle Village site (immediately south of the Sandown Park area of the Site) was also formerly part of the landfill. Groundwater quality and impacts (if any) from landfill wastes are not known.	Uncertain - however likely to be limited significance if impacts are of a similar nature and magnitude to those apparent at/down gradient of the Site.	Seek details of any monitoring undertaken for Fremantle Village Site relevant and available down gradient monitoring bores for comparison with data from existing/expanded monitoring network. If no suitable data available, obtain permission to access and undertake discretionary monitoring from relevant and available down gradient monitoring bores for comparison purposes.
GW7 - validity of data from down gradient private bores	Down gradient private bores may not be capable of providing fully representative groundwater quality data due to purpose and construction type/details.	Significant - off site groundwater impacts appear to be of limited magnitude only and require confirmation.	As for GW4.
GW8 - Presence of non-aqueous phase liquids (NAPL - hydrocarbons) in groundwater	Previously suspected to be potentially present however not subsequently identified as a primary contaminant of concern. Based on available data, hydrocarbons considered to be the most likely form of NAPL (if any) to be present.	Not significant unless presence identified in groundwater.	As for GW2 - GW4. If monitoring indicates presence of NAPL then: Monitoring suite to be reviewed and amended (as required). (If required) additional monitoring installations constructed to target likely groundwater impact zones.
GW9 - impact from possible future development on groundwater regime.	Future development of the Site would significantly affect the groundwater regime at the Site. Hard cover development and appropriate engineered capping system would likely limit infiltration of rainwater, subsequent leachate generation and could assist in mitigating groundwater impacts.	Significant - potential for mitigation of groundwater impacts.	Quantitative risk assessment (QRA) supported by an appropriate period of groundwater monitoring is required to determine potential effects. Determination of appropriate management measures/remediation (if required) for incorporation into Site Management Plan.

## 5.4 Ground Gases and Vapours

Identified data gaps, significance and actions concerning ground gases and vapours are presented below.

Table 6 Ground Gases and Vapours: Data Gaps

Data Gap	Details	Significance	Action
GV1 - gas migration potential at Daly Street area boundaries	Extent of former quarry and possibly landfill waste indicated to extend beyond current northern and eastern boundary onto adjacent land in commercial use. Waste also appears to extend up to western boundary.	Highly significant. Source and/or enhanced migration pathway may extend beyond the Site boundaries.	Additional installations at adjacent land to the west, north and east of Site boundary. Monitoring of current on-site and new off-site installations for gases and vapours. Qualitative screening assessment of results. To be supported by construction details for adjacent buildings/structures to clarify potential pathways for exposure. Quantitative risk assessment for potentially unacceptable risks to relevant adjacent receptors identified from above (if any). Determination of appropriate management measures/remediation for incorporation into Site Management Plan.
GV2 - cross boundary migration at southern boundary of Sandown Park	Landfill extends beyond southern boundary of Sandown Park onto adjacent Fremantle Village site. Fremantle Village is not accessible and limited information only is available concerning gas and vapour regime at that site..	Limited significance (current use) due to management measures in place at Fremantle Village site. Significant (possible future development) due to possible development influence on the gas and vapour regime and cross boundary migration.	Possible future development. Quantitative risk assessment to determine possible cross boundary gas and vapour regime effects (on-site and off-site) from change in site circumstances due to development. Determination of appropriate management measures/remediation for incorporation into Site Management Plan. Further monitoring to confirm seasonal influences upon gas and vapour regime to support above assessment.
GV3 - gas generating capacity of waste/fill materials	Gas monitoring has been undertaken to characterise the gas regime at the Site. Further data is required to estimate the gas generating potential of waste/fill materials in support of future work.	Significant (current use) - to assist in determining remaining gas generating potential of wastes in current site condition. Significant (future use) - to assist in assessment of future risk, remediation solutions/protective measures. Opportunity for bulk soil sampling of waste materials significantly constrained by GC1.	If possible with respect to GC1 constraints, conduct: Limited scale bulk soil sampling for visual characterisation and laboratory testing of relevant parameters. Assessment of gas generating potential of waste (back analysis from details of wastes and relevant laboratory data).
GV4 - vapour species	Variable PID concentrations detected in monitoring (with some higher readings potentially resulting from moisture content influences). Confirmation of vapour species and concentrations has not yet been	Significant - confirmation of vapour species required to determine if a vapour hazard exists and if present, risk posed to relevant receptors (on-site and off-site receptors for current use and possible future development use).	Monitoring of installations (photo ionisation detector) to confirm current understanding of vapour regime. Sampling of representative installations for gases and vapours based on above and analysis for suite of ground gases and vapours.

	determined.		Quantitative risk assessment of potentially unacceptable risks to relevant receptors identified from above (if any). Determination of appropriate management measures/remediation (if required) for incorporation into Site Management Plan.
GV5 - impact from possible future development on gas regime.	Future development of the Site would significantly affect the gas regime. Without appropriate protective measures, enhanced potential for gas accumulation and migration would likely occur (see also GC3).	Significant - likely to constrain form of development possible and protective measures required are likely to be substantial. Provision of remediation solutions and protective measures significantly constrained by GC1.	Quantitative risk assessment (QRA) of potentially unacceptable risks to relevant receptors. Further monitoring to confirm seasonal influences upon gas and vapour regime to support above assessment. Significant further work expected to be necessary beyond QRA to determine remediation/management measures needed to address likely risks to relevant future development receptors and existing receptors at adjacent land. Incorporation of above into Site Management Plan.
GV6 - potential for generation of vapour phase from light non aqueous phase liquids (hydrocarbons).	Previously suspected to be potentially present however not subsequently identified as a primary contaminant of concern.	Not significant unless presence identified in groundwater.	As for GW8 and qualitative and/or quantitative risk assessment to assess risks to relevant receptors. Determination of appropriate management measures/remediation (if required) for incorporation into Site Management Plan.
GV7 - potential gases in dissolved form.	Potential for gases to exist in dissolved form and able to migrate to a receptor.	Not significant unless presence identified in groundwater.	Undertake discretionary monitoring from relevant and available down gradient monitoring bores. If detected, quantitative risk assessment to assess risks to relevant receptors. Determination of appropriate management measures/remediation (if required) for incorporation into Site Management Plan.

## 5.5 Priority

For the data gaps identified, a relative order of priority has also been established based upon previous assessment (GHD 2011) and is summarised in the table below. The order of priority is preliminary in nature, recognising that the process of implementing actions to address these is iterative in nature; as each action is completed, the information obtained will be used to update and refine the understanding of the Site presented in the Conceptual Site Model (CSM) at reporting stage until this understanding reaches the point that selection and/or design of remediation or other risk management measures can be carried out and presented in a final stage Site Management Plan.

**Table 7 Preliminary Order of Priority for Identified Actions (Site in current use)**

Priority	Action	Detail
1	GV1	Gas migration at Daly St boundaries.
2	GC5	Daly St landfill extent
3	GC1	Quarantine waste enquiries
4	GV4	Vapour Species
5	GV3	Gas generation potential of wastes
6	GW1,2,3,4	Hydrogeological regime – expand network: up gradient, down gradient and scale of impacts (GW4 also to address GW7: validity of previously obtained data from private bores and GW 1-4 also to address GV6: Vapour from groundwater/NAPL and GW8: NAPL in groundwater)
7	GV7	Gases in dissolved form
8	GW6	Groundwater impact from Fremantle Village

**Table 8 Preliminary Order of Priority for Additional Identified Actions (if contemplating Site Redevelopment)**

Priority	Action	Detail
1	GV5	Impact from possible future development on gas regime
2	GV2	Cross boundary migration at Southern boundary of Site with adjacent Fremantle Village
3	GC2	General Site contamination characteristics
4	GC4	Munitions consideration
5	GC3	Ground stability characteristics
6	GW9	Impact from possible future development on groundwater regime

# 6. Interim Site Management Plan Strategy

## 6.1 Roles and Responsibilities

For the purpose of the Interim Site Management Plan, the following definitions apply:

**Principal:** City of Fremantle; responsible for implementation of the existing South Fremantle Landfill Site Environmental Management Plan – Interim (City of Fremantle 2004).

**Auditor:** The Auditor is responsible for reviewing the I-SMP to confirm that the proposed actions and timescale are appropriate.

**Environmental Consultant:** The environmental consultant appointed by the City of Fremantle, responsible for relevant interim actions to address identified data gaps.

**Contractor:** The company/s contracted to undertake investigation related in support of the above.

## 6.2 Aim and Objectives

The aim of the I-SMP is to set out a programme for required interim actions to address identified data gaps that will be implemented in a staged approach to assessment and management of Site contamination issues, assuming this remains in its current undeveloped form. I-SMP actions to address the identified data gaps are expected to allow management of the Site to proceed to the 'Final' Remediation or Site Management Plan stage in which selection and/or design of remediation (and/or other risk management measures) will take place for subsequent implementation as part of a staged approach to management of contamination. Although not proposed at this time, the I-SMP also aims to document additional actions to be implemented should redevelopment of the Site for a more sensitive use than the current 'use' be contemplated.

The specific objectives of the I-SMP scope of work are to:

- Present a formal interim management plan document presenting the previously identified DSR interim actions to address current data gaps (GHD 2011) as a prioritised schedule of actions/works;
- Present an indicative programme for implementation of interim actions (GHD 2011);
- Submit the I-SMP to the Department of Environment and Conservation (DEC) Accredited Contaminated Site Auditor, Mr Jason Clay of AECOM for endorsement of the prioritised schedule of actions to allow subsequent implementation (as a separate scope/scopes of work).

It should be noted that the I-SMP is not intended to provide a Sampling and Analysis Plan or other detailed specification for proposed interim actions to address data gaps. Where relevant, these will be developed separately as an integral part of the proposed scope of work for the relevant interim actions.

Preliminary cost estimates for relevant interim actions for use by City of Fremantle for budgeting purposes are also included in the current scope of work. These are to be provided separately to City of Fremantle and are not included in this report.

### 6.3 Overview and Scope

The data gaps to be addressed by interim site management measures are summarised in Section 5). The interim actions (GV, GC, GW) to be implemented to address the identified data gaps as summarised in the following Sections. Also included are possible additional actions (annotated 'AA' that may be necessary depending upon the outcomes of certain of the proposed interim actions.

It should be noted that the overall process is iterative in nature; as each action is completed, the information obtained will be used to update and refine the understanding of the Site presented in the Conceptual Site Model (CSM) at reporting stage until this understanding reaches the point that selection and/or design of remediation or other risk management measures can be carried out and presented in a 'final' Remediation or Site Management Plan (SMP) to address risks with respect to the site in current 'use'.

Table 9 Interim Site Management Plan – Interim actions to address data gaps

Interim Site Management Plan – Interim actions to address data gaps						
Data Gap (See Note 5)	Details	Specific Action Reference	Preliminary Scope (see Note 1)	Additional Details (See Note 1)		
Interim Actions	GV1	Offsite Gas and vapour risk: Daly St	GV1.1	Install gas monitoring wells beyond Daly St area site boundary	Assume 16 no. gas wells beyond site boundary to west (5), north (5) and east of Daly St area (6)	
			GV1.2	Initial gas and vapour monitoring period	Assume 3 months initial monitoring period (3 monthly events) including relevant and accessible services infrastructure	
			GV1.3	Annual gas monitoring event of installations to support assessment	Onsite + offsite wells at remainder of site for confirmatory purposes of site wide gas regime and to provide additional data points to support development of final site management plan. Assume carried out in winter. FY 2013-14 included only included in cost assessment	
	GC5	Establish extent of landfill to the north of Daly St area	GC5.1	Bores to investigate ground conditions beyond Daly St area site boundary	Use GV1.1 bores to address this data gap	
	GV4	Identify vapour species	GV4.1	Sampling and laboratory analysis to confirm vapour species detected in previous monitoring by Photo Ionisation Detector (PID)	Active or passive vapour sampling and confirmatory laboratory analysis to be undertaken from selected monitoring installations in areas displaying elevated PID readings in previous monitoring	
	GW1	Hydrogeological regime - resolve uncertainties including GW2 - Background (up gradient) water quality, GW3 - Scale of groundwater impacts, GW4 - Down gradient groundwater quality characteristics, GW7 - Validity of data from down gradient private bores	GW1.1	Confirm serviceability and elevation of existing groundwater monitoring installations (to form part of expanded network)	Assume 20 existing on site bores + 3 existing North Coogee foreshore bores to be assessed and surveyed.	
			GW1.2	Seek permission of City of Cockburn to incorporate relevant bores known to have been installed at North Coogee foreshore (WSW/down gradient of the Site)	North Coogee Foreshore bores MW5, MW9, MW1	
			GW1.3	Expand groundwater monitoring work beyond the Site to resolve current inconsistencies	Install up gradient offsite wells (3 no.)	
			GW1.4	Expand groundwater monitoring work beyond the Site to resolve current inconsistencies	Install down gradient off site wells (3 no.)	
			GW1.5	Groundwater monitoring programme, analysis and final report	New offsite wells (6 no.), selected existing serviceable on site wells (11 no.) and existing North Coogee Foreshore wells (3 no.) with two targeted groundwater monitoring events to capture summer (low) and winter (high) groundwater quality at the site and up and down gradient to confirm background water quality and the scale of impact attributable to the Site.	



Interim Site Management Plan – Interim actions to address data gaps					
Data Gap (See Note 5)	Details	Specific Action Reference	Preliminary Scope (see Note 1)	Additional Details (See Note 1)	
Interim Actions	GC1	Quarantine waste enquiries	GC1.1	Seek further clarification on this matter from AQIS to ensure that there is no residual knowledge of this matter remaining within its corporate memory that may assist in addressing this constraint.	Time allowance for pursuing enquiries with AQIS only. See AA1.6 for possible additional work that may be required.
	GV3	Gas generation potential of wastes	GV3.1	Limited on site investigation of waste mass	Shallow depth trial pit based investigation at selected locations (Daly St 5 locations, Hollis Park 3 locations, Sandown Park 5 locations) to confirm waste characteristics such as proportions of inert and degradable matter. No allowance for deep investigation of waste materials (currently assumed this can be assessed using existing investigation data).
			GV3.2	Assessment of gas generation potential	Assessment using existing reporting, limited on site investigation of materials, estimates of waste volumes and extrapolation of gas generation rates and volumes
	GW6	Groundwater impact from Fremantle Village	GW6.1	Down gradient monitoring of existing offsite bores	No specific action included. Seek to determine relevance to SFLS initially from GW 1 actions (down gradient monitoring of North Coogee Foreshore bores MW1, MW5, MW9)
	GW5	Impact upon marine water quality	GW5.1	Assume determined from GW1.5 action above	Determine using proposed down gradient wells and screening assessment (comparison of groundwater quality characteristics with relevant assessment criteria).
	GV7	Gases in dissolved form	GV7.1	Analysis undertaken upon selected groundwater samples	Assume 3 on site bores and 6 offsite bores (3 up gradient, 3 down gradient) sampled in winter monitoring event in GW1.5 above to maximise cost efficiency (i.e. analytical costs only)

Interim Site Management Plan – Interim actions to address data gaps					
	Data Gap (See Note 5)		Specific Action Reference	Preliminary Scope (see Note 1)	Additional Details (See Note 1)
		Details			
Possible Additional Interim Actions	AA	Additional actions that <b>may</b> be identified to be necessary during interim site management process	AA1.1	Additional gas monitoring bores beyond site boundary (Sandown Park and possibly Daly St), monitoring, reporting	Depending on outcome of GV1, GV3, GV7 if there is an indication of deep migration of gases/vapours from the Site.
			AA1.2	Internal gas survey of off site buildings - 2 day duration fieldwork + reporting	
			AA1.3	Vapour risk assessment - if GV1, GV4 indicate risk to relevant receptors from vapour species	Quantitative risk assessment, possibly supported by limited additional vapour sampling (existing monitoring wells and/or indoor air quality)
			AA1.4	Additional annual gas monitoring of gas wells during the interim site management phase - if uncertainties are identified from GV interim actions.	Monitoring of all existing wells (or potentially limit to selected wells only if GV interim actions indicate this is will be sufficient) for confirmation of gas regime and to provide additional data points to support development of final site management plan.
			AA1.5	Additional annual groundwater monitoring of groundwater wells during the interim site management phase - - if uncertainties are identified from GV interim actions.	For confirmation of local area groundwater quality characteristics and to provide additional data points to support development comprises monitoring of 11 existing on site wells + 3 new upgradient + 3 new down gradient + 3 existing City of Cockburn down gradient wells (or potentially limit to selected wells only if GW interim actions indicate this is will be sufficient).
			AA1.6	Undertake risk assessment with respect to quarantine waste, future works and appropriate management measures for incorporation into Site Management Plan. Scope dependent upon outcome from above enquiry.	Not included - requirement to be determined based on outcome from above and limitations/implications for any future disturbance of relevant areas/waste materials.
			AA1.7	Presence of non aqueous phase liquids (NAPL - hydrocarbons) in groundwater	Not significant at this time unless presence indicated in GW1-4 scope of work. If presence indicated then review/amend groundwater monitoring suite and (if required install additional monitoring wells to target likely impact zones).

1. Details of scope of work/additional details are preliminary in nature derived for indicative programming and preliminary cost estimating purposes. These are subject to development of details programmes of work/Sampling and Analysis plans (SAP) and review by the appointed Contaminated Sites Auditor and are therefore subject to variation.

In addition to the above proposed interim actions, it should be noted that there are also relevant<sup>1</sup> interim environmental management measures that have been already implemented directly by City of Fremantle to protect public health (City of Fremantle 2004). The relevant measures are managed directly by City of Fremantle and comprise measures to address issues which are summarised below for information purposes only:

- Unauthorised access and activities;
- Surface water contamination;
- Stormwater runoff;
- Dust and air-borne contaminants;
- Firebreaks;
- Soil contamination;
- Asbestos;
- Land instability
- Illegal dumping;

A copy of the South Fremantle Landfill Site Environmental Management Plan - Interim (City of Fremantle 2004) is presented as Appendix B for information purposes only.

#### 6.4 'Final' Remediation or Site Management Plan

For information purposes, actions that are currently anticipated will be needed to prepare a 'final' stage Remediation and Validation Plan or Site Management Plan are presented below. It should however be noted the activities that will be required are subject to amendment in accordance with:

- Outcomes from implementation of interim actions (GV, GC, GW);
- Outcomes from any additional interim actions (AA) that may also be required.

---

<sup>1</sup> i.e. those which do not conflict with or are not otherwise superseded by the interim measures set out in Section 6.3.

Table 10 Anticipated 'final' Remediation and Validation or Site Management Actions

Anticipated 'final' Remediation and Validation or Site Management Actions					
'Final' Site Management	SM1	Develop (final) Site management plan	SM1.1	Development of final Site Management Plan for implementation. Objective: management of identified contamination issues such that risks to relevant receptors are addressed and the Site can be reclassified as Remediated for restricted use (e.g. continuation of current 'use', formal public open space, solar farm or other low sensitivity use) along with any relevant ongoing site management measures needed to maintain the classification.	Gas generation model
					Leachate generation model
					Gas management measures - design and specification
					Leachate management measures - design and specification
					Earthworks reprofiling Design
					Capping specification
					Other
					Validation sampling/monitoring
					Ongoing management measures
	SM2	Implementation of final Site Management Plan	SM2.1	Implementation of management measures to achieve SMP objective	Contract and specification for works to be implemented
			SM2.2		Procurement process
			SM2.3		Implementation(remediation works)
			SM2.4		Validation of the works and validation reporting
SM3	Ongoing site management	SM3.1	Relevant ongoing site management measures required to manage residual risks posed by the Site	To be determined. May comprise maintenance of gas management measures, maintenance of cover system/s, particular safety protocols for future maintenance activity involving intrusive work, periodic inspection of management measures, and contingency measures.	
SM4	Carbon offsets	SM4.1	Possible carbon <b>credits</b> arising from implementation of measures to capture and/or destroy greenhouse gases	Assessment, reporting, application and approvals process	

## 6.5 Possible further interim actions should redevelopment for a more sensitive use be contemplated

The point at which the final Remediation or Site Management Plan can be prepared and implemented depends upon the intended Site use and desired classification with respect to the Contaminated Sites Act (2003). In previous assessment (GHD 2011) a number of further actions were identified as additionally relevant to redevelopment of the Site should a more sensitive use at any point be contemplated rather than the current 'use'.

These further actions may, in theory, be implemented at any point following a decision to pursue redevelopment for a more sensitive use. However, implementation of a separate phase of remediation for a more sensitive form of development after implementing the envisaged 'final' remediation/site management measures for the current 'use' would likely incur substantial additional cost.

City of Fremantle does not at this time intend to redevelop the Site for a more sensitive end use and the identified further actions referred to above are presented below and in the timeline for information purposes only.

Table 11 Interim Site Management Plan – Possible further interim actions (redevelopment for more sensitive use)

Interim Site Management Plan – Possible further interim actions					
	Data Gap (See Note 5)	Details	Specific Action Reference	Preliminary Scope (see Note 1)	Additional Details (See Note 1)
<b>Possible redevelopment for a more sensitive use</b>	Possible redevelopment scenario	Further interim actions that will need to be implemented if redevelopment for a more sensitive use is contemplated. 2503807	GV5	Impact from possible future development on gas regime	Assess development proposals (preliminary/detailed) Develop Conceptual Site Model, derive parameters, modelling, risk assessment
			GV2	Cross boundary migration at Southern boundary of Site with adjacent Fremantle Village	Review available data for Fremantle Village Site, off site monitoring wells to the south of Sandown Park, input to GV5 assessment.
			GC2	General Site contamination characteristics	Includes (but not necessarily limited to) further investigation of near surface soil characteristics to address risks to potential receptors (future site users) and requirements for management
			GC4	Munitions consideration	Additional enquiries (if any are possible on this matter), risk assessment. Investigation/ordnance assessment of relevant disposal locations if these can be identified and an appropriate means of investigation is available.
			GC3	Ground stability characteristics	Geotechnical investigation and assessment of ground stability/settlement characteristics including sensitivity of proposed structures and consideration of possible adverse effects arising from ground treatment methods
			GW9	Impact from possible future development on groundwater regime	Leachate and hydrogeological modelling assessment of impact arising from changes to hydrogeological characteristics of the Site arising from development.
			-	Development of Redevelopment stage Site Management Plan for implementation (if the 'final' SMP for low sensitivity future use has already been prepared and implemented)	Scope includes SMP actions (above) and other actions informed by GV5 ,GV2 ,GC4, GC3, GW9 required to address greater risk and greater need for management measures/remediation to allow a more sensitive future use.
			-		

## 6.6 Proposed Timeline

The proposed interim site management measures to address identified data gaps should be conducted in a logical, staged manner as set out in the timeline at (Appendix C) according to the significance and resultant priority of the data gaps concerned (GHD 2011).

## 7. Community Consultation

The City of Fremantle has established the South Fremantle Stakeholder Advisory Group (SFSAG) to ensure effective communication between relevant stakeholders, including members of the local community concerning the site. City of Fremantle will liaise with the community via the SFSAG to disseminate information concerning the work to be undertaken and to provide contact details for an appointed City of Fremantle official to receive and address any queries from the local community.

In addition, the City of Fremantle will undertake the following actions to inform the local community of works at/in the vicinity of the Site to address identified data gaps:

- Issue community consultation letters
- Place a notice in relevant local papers
- Place a notice on the City of Fremantle website



## 8. Conclusions and Recommendations

GHD is of the opinion that the actions set out in this I-SMP will allow current data gaps to be addressed such that a 'Final' SMP can be prepared for implementation to manage risks to relevant receptors with respect to current undeveloped 'use'.

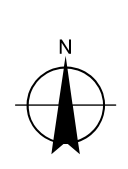
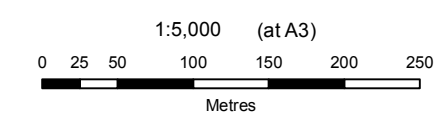
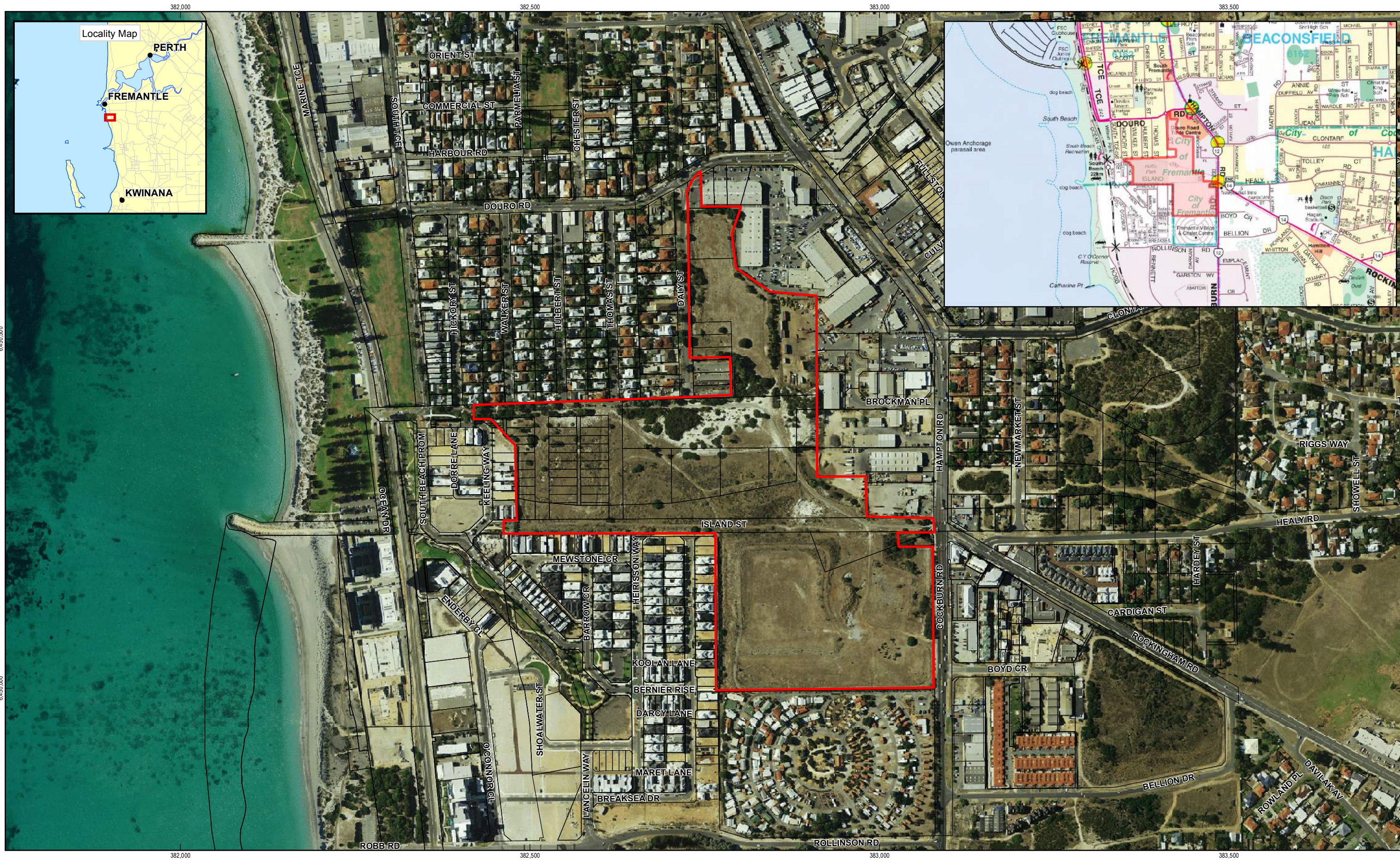
## 9. References

City of Fremantle (2004), *Environmental Management Plan Interim Jul 04 - Jun 05*

GHD (2011) *South Fremantle Landfill Site Detailed Site Review*

## Figures

Figure 1 Site Location



**LEGEND**  
 Study Area  
 Cadastre

Map Projection: Transverse Mercator  
 Horizontal Datum: Geocentric Datum of Australia (GDA)  
 Grid: Map Grid of Australia 1994, Zone 50



City of Fremantle	Job Number	61-2499900
South Fremantle Former Landfill Site	Revision	2
	Date	17 Oct 2011

**Site Location and Layout Figure 1**

G:\6124999\GIS\Maps\MXD\61\_24999\_G002\_Fig1\_Rev2.mxd  
 © 2010. While GHD has taken care to ensure the accuracy of this product, GHD, GA and LANDGATE, LANDGATE (SLIP) make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD and LANDGATE, LANDGATE (SLIP) cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.  
 Data Source: GHD: Study Area - 20100301; Landgate: Cadastre - 20100301; GA: 250k Topo Data Series III - 2006; Landgate: Metro Central Mosaic - 2011; Landgate: Road Names - 20100322, Streetsmart Directory - 2009. Created by: sismail, cskalski, slee2, bforczak

# Appendices

# Appendix A

## DEC Site Summary Form



For completion by the person(s) submitting a report(s) to be assessed by the Department of Environment and Conservation (DEC) as per the information requirements of the DEC *Reporting on Site Assessments (2001)* guideline. Completing this form enables DEC to maintain accurate records for the site.

Please note: A completed site summary form must accompany each report submitted to DEC for assessment. Each box must be filled out appropriately. Please do not write "refer to report" in any section. Copies of all relevant/current Certificates of Title must accompany this form.

Site location details:

Site name (e.g. where site may be known by a common/ business name)

Lot no.  House no.  Street

Suburb  State  Postcode

Crown Reserve (if applicable)

Certificate(s) of Title (or equivalent)

Where the subject site comprises of multiple certificates of title, please list all certificates:.....

Lot	Current Title (Volume – Folio)	Street Address
Lot 38 on diagram 20161	1192-393	38 Daly Street, South Fremantle WA 6162
Lot 12 on plan 122	1105-195	32 Daly Street, South Fremantle WA 6162
Lot 9 on plan 122	669-45	34 Daly Street, South Fremantle WA 6162
Lot 8 on plan 122	752-76	36 Daly Street, South Fremantle WA 6162
Lot 39 on diagram 20161	1192-391	39 Daly Street, South Fremantle WA 6162
Lot 203 on plan 245466	1834-964	203 Daly St, South Fremantle WA 6162
Lots 39 to 58 on plan 2019		39 to 58 Island St, South Fremantle WA 6162
Lots 32 to 34 on plan 2019	1834-964	South Fremantle WA 6162
Lots 25 to 31 on plan 2019	1834-964	25 to 31 Ocean Road, South Fremantle WA 6162
Lot 9010 on plan 50631		30 Keeling Way, South Fremantle WA 6162
Lot 1728 On plan 159082	1272-897	1728 Ocean Road, South Fremantle WA 6162
Lot 51 on plan 7217		South Fremantle WA 6162
Lot 153 on plan 7217		South Fremantle WA 6162
Lot 10 on diagram 2492	1226-104	10 Island Street, South Fremantle WA 6162
Lot 9 on diagram 2492	1226-104	9 Island Street, South Fremantle WA 6162
Lot 8 on diagram 2492	1226-104	8 Island Street, South Fremantle WA 6162
Lot 7 on diagram 2492	1226-104	7 Island Street, South Fremantle WA 6162

Lot	Current Title (Volume – Folio)	Street Address
Lot 52 on plan 7217		South Fremantle WA 6162
Lot 152 on plan 7217		South Fremantle WA 6162
Lot 1 on plan 2513	1745-017	1 Cockburn Rd South Fremantle WA 6162

Where substances have migrated beyond the cadastral boundaries of the subject site, please provide the addresses, relevant Certificates of Title documentation and owners details for all offsite properties impacted (includes soil and/or groundwater), as an attachment to this form.

Is a hard copy of Certificate of Title and associated sketch for all listed sites attached? (Y/N)

N – sites already identified in Contaminated Sites Database

WAPC reference no. (where applicable)

Current Owner/Occupier details:

Site owner (Name and address)

City of Fremantle

Site owner company ACN/ABN

ABN 74 680 272 485

Site occupier (name and address)

N/A

Site occupier company ACN/ABN

N/A

Site status (at time of reporting):

Vacant land

Proposed land use (e.g. high density residential/child care facility)

Mixed use

Identified substances and relevant media  
(e.g. benzene in soil and groundwater, xylene in soil only)

Landfill gases and vapours, inorganic and organic contaminants (nutrients, heavy metals, organic compounds) in soil and groundwater

Asbestos (Y/N)

N

Health Risk Assessment (Y/N)

N

Community health concerns identified (Y/N)

N

Radiological issues (Y/N)

N

Air quality issues (Y/N)

N

Past/present landfill (Y/N)

Y

Potential human exposure to identified substances > DEC's Health Investigation Levels or equivalent (Y/N)

Y

Other human health issues (Y/N)

N

Specify other health issues.....

Where 'yes' is recorded for at least one of the above categories, please submit two copies of the report(s) (relevant documentation) to DEC for referral to the Department of Health (or Radiological Council, in the case of radiological issues)

Are site activities licensed under the *Environmental Protection Act 1986*? (Y/N)

Licence No. N

Where laboratory analysis has been undertaken, is the laboratory NATA accredited for all analytes and analytical methodologies used? (Y/N) (If not, why not?)

N/A

Community Consultation: (as per the DEC's *Community Consultation (December 2006)* guideline)

Community consultation program commenced/proposed (Y/N)

N – currently undertaken separately by South Fremantle Landfill Site Stakeholder Advisory Group



Are consultation program details (e.g. community consultation plan) provided in attached report (Y/N)

N

History of Investigation:

Have previous site investigations been undertaken? (Y/N - if yes, please provide details below)

Y

Report title, date and author:


See below

1. Hassell Planning Consultants Pty Ltd, Soil & Rock Engineering Pty Ltd (1985), *South Fremantle Tip and Foreshore Study*.
2. CSIRO (1986), *Investigation of the Concentration of Methane Gas within the Landfill, Corner of Rollinson and Cockburn Roads, S. Fremantle, W.A.*
3. CSIRO (1989), *Investigation of Concentration of Methane Gas within the South Fremantle Landfill Site*.
4. Coffey (1989), *South Fremantle Landfill Site Geotechnical Review*.
5. City of Fremantle - Environmental Health Department (1990), *Groundwater Monitoring Report Not Cited*
6. Matprolabs (1990–1991), *Asbestos Monitoring - Stage 1 and 2 Report Not Cited*
7. City of Fremantle - Environmental Health Department (1991), *South Fremantle Tip Site Management Proposal*
8. Mackie Martin & Associates Pty Ltd (1992), *Hydrogeological investigations South Fremantle Tipsite*
9. Halpern Glick Maunsell (1994-1995), *South Fremantle Tipsite Hydrogeological and Soil Monitoring*
10. PPK Environment and Infrastructure Pty Ltd (1998), *Preliminary Investigation - South Fremantle Landfill Site*
11. OTEK (1999a), *South Fremantle Landfill GME September 1999*
12. OTEK (1999b), *Environmental Site Assessment*
13. Mitchell McCotter (1999), *Groundwater Monitoring November 1999*
14. OTEK (2000), *Environmental Site Assessment*
15. STASS (2000), *Groundwater Review*
16. IT Environmental (2001a), *South Fremantle Landfill GME March 2001*
17. IT Environmental (2001b), *South Fremantle Landfill GME September 2001*
18. PPK Environment and Infrastructure Pty Ltd (2002), *Groundwater Monitoring April 2002*
19. Parsons Brinckerhoff (2002), *Groundwater Monitoring October 2002*
20. Parsons Brinckerhoff (2003a), *Groundwater Monitoring March 2003*
21. Parsons Brinckerhoff (2003b), *Groundwater Monitoring October 2003*
22. Parsons Brinckerhoff (2004), *Groundwater Monitoring May 2004*
23. Taylor Burrell Barnett (2004), *South Fremantle Landfill Study: Feasibility Study*
24. City of Fremantle (2004), *Environmental Management Plan Interim Jul 04 - Jun 05*
25. Golder Associates (2004), *Draft Report on Information Review, Remediation Strategy, costs and risks, South Fremantle Landfill*
26. Parsons Brinckerhoff (2004), *Groundwater Monitoring October 2004*
27. Golder Associates (2005), *Review of the Groundwater Monitoring Program South Fremantle Landfill Site (DRAFT)*
28. Golder Associates (2006), *Review of the Groundwater Monitoring Program South Fremantle Landfill Site*
29. AquaTerra (2006), *Qualitative health and environmental Risk Assessment for the South Fremantle Landfill Site - Draft Report*
30. Golder Associates & Strategen (2007), *Stage 1 & 2 report - Gap analysis, work program and land use plan review*
31. WSP Environmental Pty Ltd (2007), *Annual Groundwater Monitoring Report, South Fremantle Landfill Site*
32. Golder Associates (2007), *South Fremantle Landfill Site Redevelopment Options Geotechnical and Environmental Aspects*

- 33. GHD (2010a), *South Fremantle Landfill Site Sampling and Analysis Plan*
- 34. GHD (2010b), *South Fremantle Landfill Site Proposed Revision to Monitoring Strategy – Stage 2*
- 35. GHD (2010c), *South Fremantle Landfill – Gas/Vapour Assessment Stage 2 Works Fee Proposal*
- 36. Aecom (Jason Clay) (2010), *South Fremantle Landfills Contaminated Sites Audit – Review of GHD’s “Proposed Revision to Monitoring Strategy – Stage 2”*
- 37. GHD (2010d), *South Fremantle Landfill site Response to Auditors Comments*
- 38. GHD (2010e), *South Fremantle Landfill Site Interim Assessment of Landfill Gas/Vapour Risk*
- 39. GHD (2011a), *South Fremantle Landfill Site Detailed Site Review Proposal*
- 40. Aecom (Jason Clay) (2011b), *South Fremantle Landfills Contaminated Sites Audit - Update*

Declaration:

The information contained in this site summary form is a true representation of the information contained in the attached report(s)/document(s).

Full name (print)	Simon French		
Position held	Principal Scientist, GHD Pty Ltd		
Signature		Date	02/11/2012

Please ensure that a hardcopy of the current Certificate(s) of Title and associated sketch accompanies the site summary form. DEC cannot proceed with the assessment of the report if this information is not provided.

-----  
DEC Registrar Only

Registrar name:		Signature:	
CoT verified (Y/N)		Owner details verified (Y/N)	
		Complete form (Y/N)	
Awaiting Classification (Y/N)			
Awaiting Re-Classification (Y/N)			
Incomplete Form (Y/N)			
LWQB Assessment Officer:			
Comments/Actions:			
Date of data entry:			

-----

# Appendix B

South Fremantle Landfill Site Environmental  
Management Plan – Interim. City of Fremantle 2004.

---

# South Fremantle Landfill Site

## Environmental Management Plan

### Interim

August 2004 - June 2005



City of Fremantle  
August 2004  
Final

---

## **TABLE OF CONTENTS**

<b>SUMMARY .....</b>	<b>1</b>
<b>BACKGROUND.....</b>	<b>1</b>
<b>APPLICATION .....</b>	<b>1</b>
<b>OBJECTIVES.....</b>	<b>2</b>
<b>OWNERSHIP OF MANAGEMENT PLAN .....</b>	<b>2</b>
<b>STATE GOVERNMENT DEPARTMENT’S – POSITIONS AND CITY OF FREMANTLE RESPONSE .....</b>	<b>2</b>
<b>MANAGEMENT ISSUES AND PROCEDURES.....</b>	<b>3</b>
<b>Unauthorised Access and Activities .....</b>	<b>4</b>
Objective.....	4
Current Management Approach.....	4
Short Term Management Approach.....	4
Budget .....	4
Supporting Officer’s.....	4
<b>Groundwater Contamination.....</b>	<b>4</b>
Objective.....	4
Current Management Approach.....	5
Short Term Management Approach.....	5
Budget .....	5
Supporting Officer .....	5
<b>Surfacewater Contamination.....</b>	<b>5</b>
Objective.....	5
Current Management Approach.....	5
Short Term Management Approach.....	5
Budget .....	6
Supporting Officer’s.....	6
<b>Stormwater Runoff .....</b>	<b>6</b>
Objective.....	6
Current Management Approach.....	6
Short Term Management Approach.....	6
Budget .....	6
Supporting Officer’s.....	6
<b>Dust Generation And Air-Borne Contaminants.....</b>	<b>6</b>
Objective.....	6
Current Management Approach.....	6

Short Term Management Approach .....	7
Budget .....	7
Supporting Officer's .....	7
<b>Firebreaks .....</b>	<b>7</b>
Objective.....	7
Current Management Approach .....	7
Short Term Management Approach .....	8
Budget .....	8
Supporting Officer's .....	8
<b>Soil Contamination.....</b>	<b>8</b>
Objective.....	8
Current Management Approach .....	8
Short Term Management Approach .....	8
Budget .....	8
Supporting Officer's .....	8
<b>Asbestos .....</b>	<b>9</b>
Objective.....	9
Current Management Approach .....	9
Short Term Management Approach .....	9
Budget .....	9
Supporting Officer .....	9
<b>Land Instability .....</b>	<b>9</b>
Objective.....	9
Current Management Approach .....	9
Short Term Management Approach .....	9
Budget .....	10
Supporting Officer .....	10
<b>Methane And Landfill Gas Generation .....</b>	<b>10</b>
Objective.....	10
Current Management Approach .....	10
Short Term Management Approach .....	10
Budget .....	10
Supporting Officer .....	10
<b>Illegal Dumping.....</b>	<b>10</b>
Objective.....	10
Current Management Approach .....	10
Short Term Management Approach .....	11
Budget .....	11
Supporting Officer's .....	11
<b>EVALUATION AND REVIEW .....</b>	<b>11</b>
<b>APPENDIX 1 .....</b>	<b>12</b>

<b>Relevant reports relating to the South Fremantle Landfill Site (as at March 2004 and in date order)</b> .....	<b>12</b>
<b>APPENDIX 2</b> .....	<b>14</b>
<b>Correspondence from the Department of Environment</b> .....	<b>14</b>
<b>Correspondence from the Department of Health</b> .....	<b>16</b>
<b>APPENDIX 3</b> .....	<b>18</b>
<b>Groundwater Monitoring Program 2004-2005 – South Fremantle Landfill Site</b> .....	<b>18</b>
Introduction.....	18
Current Groundwater Monitoring Program (since March 2002).....	18
Groundwater Monitoring Program 2004-2005.....	19
Guide to abbreviations .....	20
Parameter: Heavy Metals / Metalloids (Cu, Ni, Pb, Cr, Fe, Cd, As, Zn, Hg, Se, Mn, Mg, Ba)....	21
Parameter: TPH.....	23
Parameter: PAH .....	25
Parameter: BTEX .....	27
Parameter: Phenols.....	29
Parameter: OC/OP .....	31
Parameter: Triazine Pesticides .....	33
Parameter: PCBs .....	35
Parameter: Fatty Acids (Organic Acids).....	37
Parameter: Pathogen Analyses (E-coli and Bacteria Counts) .....	39

## Summary

The City of Fremantle, at the request of Council, has prepared this short term management plan for the South Fremantle Landfill site in order to manage environmental and health issues from the site.

## Background

The City of Fremantle has undertaken a number of investigations and studies (Refer to Appendix 1) to ascertain the environmental and health issues for the South Fremantle Landfill site over the last 20 years since the site has been closed. The site however, does not have a complete management plan or approach to deal with the issues onsite and this plan attempts to resolve this matter for the interim.

A Feasibility Study into developing the South Fremantle Landfill Site has been in progress since June 2002 and to this date, no long term future plans for the site have been agreed upon. As such this Management Plan will stay in force till Council determines the future use of the site and who will be responsible for the site in the long term. The Management Plan will be reviewed every 12 months to make sure it is relevant and useful.

## Application

This Management Plan applies to the entire South Fremantle Landfill site and addresses both onsite and offsite issues that result from the presence of the landfill as defined in Map 1.



**Map 1: South Fremantle Landfill Site**

This Management Plan comes into affect once Council endorses the Plan and ends once ownership of the site transfers to another party.



This Management Plan is only relevant and applies to the 30 June 2005 and for the site in its state at the time of writing this document (initiated in June 2004).

If a decision is not made on the final and agreed land use for the site by April 2005 and the site is likely to remain as is for more than 5 years from June 2004, a long term Management Plan will need to be developed. The long term Management Plan is to be developed before the end of June 2005 and approved by the Department of Environment and Department of Health.

This Management Plan does not cover the management of any land disturbing activities onsite nor any other activity unless prior approval is granted by the relevant authorities.

## **Objectives**

The key objective of this Management Plan is to protect the environment, people accessing the site and nearby residents from any environmental or health impacts that may result from the presence of the landfill.

The other objective is to provide Council and the community a clear understanding of who, how and the manner in which these issues will be managed to ensure transparency and accountability in the management decisions and actions taken for the South Fremantle Landfill site.

## **Ownership of Management Plan**

The City of Fremantle owns the majority of the South Fremantle Landfill site (remainder owned by Mains Roads WA).

Management of properties rests with the Property Co-ordinator and as such will be responsible for the implementation of this management plan. The Property Co-ordinator will be supported by a range of staff at the City of Fremantle and consultants as required.

In the first instance, the Property Co-ordinator is to be contacted regarding any issues regarding the site.

The Property Co-ordinator is also to communicate and respond to community concerns regarding the management plan and its implementation on a regular basis either through the Precinct system or through some other forum as appropriate to the needs of the community.

## **State Government Department's – Positions and City of Fremantle Response**

The City of Fremantle has over time received letters from the Department of Environment and Department of Health regarding environmental and health issues related to the site.

Both the Department of Environment and Department of Health have stated in written advice to the City of Fremantle to either fence the site or place a cap with a suitable impervious layer of clay so as to prevent further generation of leachate and possible

access to contaminated soil. Over time, advice has also included the need to fence the site.

The Feasibility Study into land use options for the South Fremantle Landfill site identified significant costs associated with fencing and/or capping the site (over \$300,000 for fencing and \$9 million for capping). As such, no decision has been made to either fence or cap the site on the basis of cost and the unknown future land use of the site.

Since the completion of the Feasibility Study, the City of Fremantle has entered into a Memorandum of Understanding with LandCorp to further investigate the feasibility of remediating the site for alternative land uses.

During the preparation of this management plan, the draft was sent to the Department of Environment and Department of Health for comment (refer to Appendix 2 for copies of correspondence).

The Department of Health have advised that in order to mitigate human health risks associated with the site, issues such as landfill gas generation, contact with contaminated waste and subsidence need to be addressed as a matter of priority. The Department of Health states clearly that the site be fenced to restrict access and that an air quality management plan is developed and implemented in accordance with their requirements.

The Department of Environment further endorses the need to fence the site in order to restrict public access to potentially contaminated material. In addition, the Department requires the development of a long term management plan for the site.

## Management Issues and Procedures

The key environmental and health issues relating to the landfill site are (and not in order of priority):

- Unauthorised access and activities onsite
- Groundwater contamination
- Surfacewater contamination
- Stormwater drainage
- Dust generation and air-borne contaminants
- Firebreaks
- Soil contamination
- Asbestos
- Land instability
- Methane generation
- Illegal dumping

The following objectives and management procedures have been designed to ensure environmental and health risks associated with the above issues are minimised in the short term.

### **UNAUTHORISED ACCESS AND ACTIVITIES**

#### **Objective**

To ensure only authorised personnel access the site.

#### **Current Management Approach**

The landfill site is visited to ensure camping and other activities including bottle collection do not occur. Signs are placed around the site stating the “site is under remediation” however it isn’t enough to deter unauthorised access.

#### **Short Term Management Approach**

The site is to be fenced within 3 months of the Council decision to adopt this management plan. The existing east-west cycle/footpath is to remain open to public access but the rest of the site is to be fenced with suitable material so as to prevent unauthorised access.

Suitable information boards to be placed around the site advising the land is a former landfill site and access is prohibited. Signs will be inspected as part of the normal patrol. Other signs are to be removed as per the Council’s Signage policy.

Chains will be reinstated on the Hollis Park end of the cycle path to restrict vehicular access.

#### **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

#### **Supporting Officer’s**

Manager of Urban Environment and Control

Manager, City Works

Rangers, Urban Environment - Patrols

Risk Management Co-ordinator - Signage

### **GROUNDWATER CONTAMINATION**

#### **Objective**

To ensure groundwater contamination does not reach a level which threatens ecological processes in receptor environments or affects the health of nearby residents in the event of accessing groundwater that may be contaminated.

### **Current Management Approach**

Six monthly groundwater monitoring is undertaken both onsite and offsite of the landfill site for a number of parameters (refer to Appendix 3 - Groundwater Monitoring Program for the South Fremantle Landfill Site for more information). Monitoring is undertaken in the months of March/April and September/October of each year.

Reports prepared are sent to the Department of Environment and Department of Health for assessment and advice which is then incorporated in the next groundwater monitoring program.

Where exceedances of parameters occur, liaison with the Department of Environment and Department of Health is undertaken to ensure the risk to human health and the environment is negligible.

The reports are made publicly available in the library and private bore owners receive copies of the reports as well.

### **Short Term Management Approach**

To continue with the current management approach, with a review of the parameters monitored undertaken after the September/October 2005 groundwater monitoring round.

A long term management plan to ensure groundwater contamination at the landfill does not pose a risk or have the potential to pose a risk to either human health or the environment is to be developed before the end of June 2005.

### **Budget**

City of Fremantle Funds - \$37,000 per year.

### **Supporting Officer**

Environmental Planner

Consultants

### **SURFACEWATER CONTAMINATION**

#### **Objective**

To ensure any potentially contaminated surfacewater is contained and retained onsite so as to reduce offsite migration of contaminants.

#### **Current Management Approach**

The landfill site has been contoured to ensure surfacewater is retained onsite.

#### **Short Term Management Approach**

To continue with the current management approach and to review, following a significant rainfall event, the performance of the current stormwater retention basins. Where recontouring is required, this should be done without delay.

### **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

### **Supporting Officer's**

Environmental Planner

Manager, City Works

### **STORMWATER RUNOFF**

#### **Objective**

To ensure stormwater is contained onsite.

#### **Current Management Approach**

The landfill site has been contoured to ensure stormwater is retained onsite.

#### **Short Term Management Approach**

To continue with the current management approach and to review, following a significant rainfall event, the performance of the current stormwater retention basins. Where recontouring is required, this should be done without delay.

### **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

### **Supporting Officer's**

Environmental Planner

Manager, City Works

### **DUST GENERATION AND AIR-BORNE CONTAMINANTS**

#### **Objective**

To limit dust generation and air-borne contaminants as a result by activities undertaken onsite.

#### **Current Management Approach**

Dust generation is limited where possible. Prior to the grading of firebreaks, nearby residents are notified via mail to advise them of the dates when firebreaks will be graded. Grading for firebreaks are only carried out under ideal weather conditions (low wind) where possible to ensure dust does not migrate offsite. If weather conditions change so as to generate dust and affect adjacent property owners, firebreak excavations are immediately stopped.

Vegetative cover (mostly weeds) is retained onsite to limit the area of clear land exposed to wind. Vegetative cover is cut back every 12 months (in November) to reduce fuel loads and fire risks.

### **Short Term Management Approach**

Develop and implement an air quality management plan consistent with the Department of Environment and Department of Health requirements.

Subject to the recommendations of the air quality management plan, continue with the current management approach with the additional requirement of watering down the areas where activities such as firebreak creation may cause dust generation. An inventory of the number of complaints received as a result of dust generation and air borne contaminants onsite will also be established.

To identify soil contaminated areas that need to be covered with inert material to reduce the amount of contaminated soil that may escape from the site due to dust generation/firebreak grading.

No additional soil to be placed on this site unless specifically approved in writing by the Manager of Urban Environment and Control.

### **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

### **Supporting Officer's**

Manager of Urban Environment and Control

Co-ordinator, Integrated Patrols and Rangers

Manager, City Works

### **FIREBREAKS**

#### **Objective**

To reduce the risk of fire onsite through the creation of firebreaks. This section only applies to routine firebreaks not those that may be required for actual fire management.

#### **Current Management Approach**

Firebreaks are graded onsite annually with some slashing of vegetation onsite to reduce fuel loads and fire risks. Prior to the grading of firebreaks, nearby residents are notified via mail (or letterbox drop) to advise them of the date or dates when firebreaks will be graded or cut. Grading for firebreaks will only be carried out under ideal weather conditions (low wind) where possible to ensure dust does not migrate offsite. If weather conditions change so as to generate dust and affect adjacent property owners, firebreak excavations are immediately stopped.

Vegetative cover is selectively cut back every 12 months (usually in November) to reduce fuel loads and fire risks.

### **Short Term Management Approach**

Subject to the recommendations of the air quality management plan, continue with the current management approach with the additional requirement of watering down the areas where firebreak creation may cause dust generation.

To identify soil contaminated areas that need to be covered with inert material to reduce the amount of contaminated soil that may escape from the site due to firebreak grading.

### **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

### **Supporting Officer's**

Co-ordinator, Integrated Patrols and Rangers

Manager of Urban Environment and Control

### **SOIL CONTAMINATION**

#### **Objective**

To ensure contaminated soil is not exposed on the surface in order to minimise health and environmental risks.

#### **Current Management Approach**

The landfill site has been covered with an inert capping material to varying depths across the site to reduce the exposure risk to contaminated soil.

#### **Short Term Management Approach**

The site is to be fenced to limit the likelihood of an exposure pathway from the contaminated soil to the environment or persons.

#### **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

#### **Supporting Officer's**

Environmental Planner

Manager of Urban Environment and Control

Manager, City Works

## **ASBESTOS**

### **Objective**

To ensure asbestos levels (ambient and surface soil levels) are within the legislative requirements.

### **Current Management Approach**

The landfill site has been covered with an inert capping material to varying depths across the site to reduce the exposure risk to landfill including asbestos.

### **Short Term Management Approach**

Occasionally asbestos sheeting chips are evident on the surface. Dependant on the quantity and location these chips should be collected and disposed of or covered with inert fill.

Subject to the recommendations of the air quality management plan, continue with the current management and proposed short term approach. As part of the air quality management plan, determine the need for ambient asbestos monitoring program and selective surface soil sampling to ensure the ambient and surface soil asbestos levels are within legislative requirements. Where asbestos levels are of concern, liaison with the Department of Health to ensure health risks are minimised, will be undertaken. If monitoring is required, the City of Fremantle is to undertake the steps required to ensure it is completed within 3 months of the completion of the health risk assessment.

### **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

### **Supporting Officer**

Manager of Urban Environment and Control

Consultant

## **LAND INSTABILITY**

### **Objective**

To ensure site is stable and does not pose a health risk to those that access the site.

### **Current Management Approach**

The landfill site has not been compacted since closure and has been allowed to stabilise naturally. The potential for ongoing instability is moderate due to the continuing decomposition process occurring within the putrescible sections of the landfill. Signs have been placed around the landfill advising the site is “under remediation”.

### **Short Term Management Approach**

The site is to be fenced removing the risk associated with land instability.



## **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

## **Supporting Officer**

Risk Management Co-ordinator

## **METHANE AND LANDFILL GAS GENERATION**

### **Objective**

To ensure methane and other landfill gases levels do not reach the point where explosions are likely.

### **Current Management Approach**

The landfill site has been covered with an inert capping material to varying depths across the site. This has largely allowed any methane or landfill gases generated to escape naturally to the atmosphere. In addition, no buildings are placed onsite to allow for methane or landfill gas accumulation.

### **Short Term Management Approach**

To ensure that any adjacent or onsite development does not restrict methane and landfill gases escaping to the atmosphere.

Subject to the recommendations of the air quality management plan, determine the need and if necessary, undertake landfill gas monitoring in winter and summer months or as advised by consultants with a focus on monitoring adjacent to residential properties (Daly Street preferred).

## **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

## **Supporting Officer**

Manager of Urban Environment and Control

Consultant

## **ILLEGAL DUMPING**

### **Objective**

To discourage illegal dumping of waste onsite.

### **Current Management Approach**

The landfill site is visited and where found, illegally dumped material is removed to an approved landfill site.

### **Short Term Management Approach**

The site is to be fenced which will reduce the potential for illegal dumping.

### **Budget**

Individual costing to be ascertained but will be covered by the \$50,000 allocated in the draft 2004- 2005 budget for South Fremantle Landfill Site Public Open Space management.

### **Supporting Officer's**

Rangers, Urban Environment - Visits

Manager, City Works – Removal of illegally dumped materials

## **Evaluation and Review**

The scope of this plan will be reviewed in November 2004 to ensure it includes proactive approaches to managing the site consistent with the work being undertaken by the City of Fremantle and LandCorp as part of the Memorandum of Understanding.

This plan will be reviewed in April 2005 and at least every 12 months thereafter to ensure it is relevant, useful and correct.

The Property Co-ordinator and Environmental Planner will be responsible for the review of the plan with key staff and community involvement.

## Appendix 1

### **RELEVANT REPORTS RELATING TO THE SOUTH FREMANTLE LANDFILL SITE (AS AT MARCH 2004 AND IN DATE ORDER)**

Hassell Planning Consultants Pty Ltd, 1985, South Fremantle Tip and foreshore study final report

Various authors, 1986, South Fremantle Tip Site Study Area Technical Report Document

CSIRO, 1986, Investigation of the Concentration of Methane Gas within the Landfill, Corner Rollinson and Cockburn Roads

City of Fremantle, 1989, Draft strategy plan for South Fremantle Tip Site study area: technical report document

City of Fremantle, 1989, Draft strategy plan for South Fremantle Tip Site study area

CSIRO, 1989, Investigation of concentration of methane gas within the South Fremantle landfill site / D Briegel, C. Barber and T. Power

Coffey Partners International, 1989, South Fremantle Landfill Site, Geotechnical Review

Wilson Sayer Core, 1989, Fremantle Tip Site Study Economic Evaluation

Sinclair Knight and Partners, 1989, South Fremantle Tip Site Study Area Traffic Report

Parker, Michael, 1990, An overview of the South Fremantle tip site, City of Fremantle.

Levett, Ruth, 1991, South Fremantle Tip Site management proposal, City of Fremantle

Mackie Martin & Associates, 1992, City of Fremantle hydrogeological investigations South Fremantle tipsite.

Halpern Glick Maunsell, 1994, South Freo Tipsite Hydrogeological and Soil Monitoring

PPK Environment and Infrastructure, 1998, Preliminary Investigations South Fremantle Landfill Site

OTEK Australia Pty Ltd, 1999, Environmental site assessment - landfill sites at Daly Street & Hollis Park South Fremantle, Western Australia

OTEK Aust Pty Ltd, 1999, Groundwater monitoring program - South Fremantle landfill site , South Fremantle , Western Australia

OTEK Aust Pty Ltd, 2000, Environmental site assessment Sandown Park site, Daly St, South Fremantle, Western Australia, prepared for City of Fremantle, Western Australia, May 2000

ERM Mitchell McCotter, 2000, Groundwater monitoring, November 1999, South Fremantle Landfill Site

Stass Environmental, 2000, Groundwater Review, Former South Fremantle Landfill

IT Environmental, 2001, South Fremantle Groundwater Monitoring Event, March 2001

IT Environmental, 2001, South Fremantle Groundwater Monitoring Event, November 2001

City of Fremantle, 2001, South Fremantle landfill site:community discussion paper July 2001.

PPK Environment & Infrastructure, 2002, Groundwater Monitoring April 2002, South Fremantle Landfill

PPK Environment & Infrastructure, 2002, Groundwater Monitoring April 2002, For Public Release, South Fremantle Landfill

Parsons Brinckerhoff, 2002, Groundwater Monitoring October 2002, South Fremantle Landfill

Parsons Brinckerhoff, 2002, Groundwater Monitoring October 2002, For Public Release, South Fremantle Landfill

Parsons Brinckerhoff, 2003, Groundwater Monitoring March 2003, South Fremantle Landfill



Parsons Brinckerhoff, 2003, Groundwater Monitoring March 2003, For Public Release, South Fremantle Landfill

Parsons Brinckerhoff, 2003, Groundwater Monitoring October 2003, South Fremantle Landfill

Parsons Brinckerhoff, 2003, Groundwater Monitoring October 2003, For Public Release, South Fremantle Landfill

## Appendix 2

### CORRESPONDENCE FROM THE DEPARTMENT OF ENVIRONMENT

	<b>Department of Environment</b>	<p>Your ref: Our ref: Enquiries: 11/80/299 Direct tel: Rebecca Moen 9222 8671</p>
<p>Ms Caroline Raphael Environmental Planner City of Fremantle PO Box 807 Fremantle WA 6959</p>		
<p>Dear Ms Raphael</p>		
<p><b>SOUTH FREMANTLE LANDFILL SITE INTERIM ENVIRONMENTAL MANAGEMENT PLAN</b></p>		
<p>I refer to your letter dated 12 July 2004 and the attached report entitled "<i>South Fremantle Landfill, Environmental Management Plan Interim, July 2004 to June 2005 (draft)</i>", dated July 2004, prepared by the City of Fremantle.</p>		
<p>The Department of Environment (DoE) has reviewed this Site Management Plan and whilst it is pleasing to note that a health risk assessment will be undertaken for the site, the DoE is concerned with the timeframes to undertake and implement the findings of the risk assessment. It is proposed that the health risk assessment will be completed by December 2004 and then a decision on the management of the site (i.e. fencing or capping) will be determined by April 2005. Therefore the site will remain in its current state for a further year.</p>		
<p>The DoE has previously recommended to the City of Fremantle that the entire landfill site is either fenced or capped to restrict public access to potentially contaminated material, and to date these measures have not been implemented. The DoE concurs with Department of Health's (DoH) advice to the City of Fremantle dated 20 July 2004, where the DoH advised that the Site Management Plan does not adequately mitigate human health risks for the site.</p>		
<p>In relation to the management of groundwater contamination, the DoE notes the City of Fremantle's comments that the groundwater monitoring to date indicates that the extent of the contamination at the landfill appears to be localised and has not significantly affected off-site users. The City of Fremantle has also indicated that until the future of the site is determined (i.e. the next twelve months) the management of groundwater contamination will remain as is and include biannual groundwater monitoring. The DoE is satisfied with this approach in the short term (i.e. the next twelve months). However, the DoE is aware that the site may remain in its current state for over a year and therefore recommends that a long term management strategy is developed to ensure that the groundwater contamination at the landfill site does not pose a risk or have the potential to pose a risk to either human health or the environment.</p>		
<p>Australia Square Level 8 141 St Georges Terrace Perth Western Australia 6000 Box K822 Perth Western Australia 6842 Telephone (08) 9222 7000 Facsimile (08) 9322 1598 Email info@environ.wa.gov.au www.environ.wa.gov.au</p>	 <p>WESTERN AUSTRALIAN environment AWARDS</p>	<p>Hyatt Centre Level 2 3 Plain Street East Perth Western Australia 6004 PO Box 6740 Hay Street East Perth Western Australia 6892 Telephone (08) 9278 0300 Facsimile (08) 9278 0301 National Relay Service (Australian Communication Exchange) 132 544 E-mail correspondence@wrc.wa.gov.au www.wrr.wa.gov.au</p>

Should you have any concerns or comments in relation to the above, please contact Ms Rebecca Moen of the LWQB of the DoE on 9222 8671.

Yours sincerely



Sharon Clark  
MANAGER  
LAND AND WATER QUALITY BRANCH

16 August 2004

**CORRESPONDENCE FROM THE DEPARTMENT OF HEALTH**



**Department of Health**  
Government of Western Australia

Our Ref: 03-07465  
Your Ref: CR:120704  
Enquiries: Sarah Taylor 9388 4957

Ms Caroline Raphael  
Environmental Planner  
City of Fremantle  
PO Box 807  
FREMANTLE WA 6959

<b>CITY OF FREMANTLE</b>	
DATE REC	26 JUL 2004
Class	
Subject	052/002
Property	
Sent To	SPG
	SA
No	

Dear Ms Raphael

**SOUTH FREMANTLE LANDFILL SITE – MANAGEMENT PLAN**

Thank you for your letter dated 12 July 2004 regarding the South Fremantle Landfill Site Management Plan (SFL-SMP) and your request for the Department of Health (DOH) to comment on this plan.

A review of the SFL-SMP has identified that it currently does not adequately mitigate the human health risks identified by the DOH for this site. As previously indicated in correspondence dated 8 October 2003 to your department, the issues pertaining to un-remediated landfills that are of health significance include landfill gas generation, contact with contaminated waste and subsidence. Subsidence presents a physical hazard and contact with contaminated waste presents an exposure hazard from soil, surface waters, groundwater, air and possibly through the food chain. Restricting access to the site, monitoring groundwater plume migration and managing air quality impacts are considered priority areas of management for this site. This current plan does not adequately control access to the site or address potential air quality impacts.

The SFL-SMP reports that unauthorised access and activities will be managed with regular inspection and signs stating "site is under remediation". These are not considered significant deterrents for children who can access the former landfill area and potentially come into contact with contaminated material. Further, all works on the site should be conducted in a manner to control generation of airborne hazards. I believe that by restricting soil disturbance activities to low wind velocity days and having a complaints register only partially addresses management of these hazards.

The DOH would like to reiterate its previous recommendations that the entire site be fenced to restrict access and that an air quality management plan be developed and implemented. The air quality management plan would outline control procedures to prevent generation of airborne hazards and regular cover maintenance activities.

**Environmental Health**

All Correspondence: PO Box 8172 Perth Business Centre Western Australia 6849  
Grace Vaughan House 227 Stubbs Terrace Shenton Park WA 6008  
Telephone: (08) 9388 4999 Facsimile: (08) 9388 4955  
ABN 28 684 750 332

- 2 -

Thank you for requesting my comments on this issue. I hope this clarifies our position on this matter.

Yours sincerely



Mark Feldwick  
**A/PRINCIPAL TOXICOLOGIST**

20 July 2004

cc: Sharon Clark, Department of Environment

S:\EHB\Toxi\Typing\DOCUM\2004\4714ts1a.doc



## Appendix 3

### **GROUNDWATER MONITORING PROGRAM 2004-2005 – SOUTH FREMANTLE LANDFILL SITE**

#### **Introduction**

The City of Fremantle has conducted a number of investigations and monitoring programs on the South Fremantle Landfill Site (refer to Appendix A) and to date, consistency in the groundwater monitoring parameters that have been monitored has been lacking. This groundwater monitoring program has been approved by the Department of Environment.

#### **Current Groundwater Monitoring Program (since March 2002)**

The current groundwater monitoring program includes the following tasks and analysis. This has largely been done since March 2002 to October 2003 (incorporating four groundwater monitoring events).

1. Depth to Groundwater

Measured in all existing wells (11 residential bores, 13 bores onsite and two offsite bores).

2. Direction of Groundwater Flow

Map of groundwater elevation contours and groundwater flow.

3. Quality of Groundwater

Field chemical parameters including:

- temperature;
- dissolved oxygen;
- redox potential;
- pH; and
- electrical conductivity.

Laboratory analysis of these parameters for each bore sample taken:

- pH and Electrical Conductivity
- Sulfate
- Chloride
- Nitrate
- Ammoniacal Nitrogen

- Potassium, Sodium, Calcium and Magnesium
- Ammonium
- TPH
- PAH
- BTEX
- Phenols
- OC/OP
- Triazine pesticides
- PCBs
- Heavy metal suite (ie. Cu, Ni, Pb, Cr, Fe, Cd, As, Zn, Hg, Se, Mn, Mg, Ba)
- Fatty acids (organic acids)
- Pathogen analyses (e-coli and bacteria counts)

QA/QC samples are also taken as part of the sampling program.

#### **Groundwater Monitoring Program 2004-2005**

The series of tables, as follows, outlines which bores and parameters have been monitored for since May 1999 and where exceedences and detections have occurred. Also indicated in the tables are the proposed groundwater monitoring parameters which will be monitored for the next four groundwater monitoring events. In determining which parameters should be monitored for, where accidents or detections occurred regularly (at least once a year), those parameters would be monitored every six months. Where there have been no detections, those parameters would be monitored for every 12 months to ensure they are not present within the groundwater and not posing a risk to the environment or human health.

Field chemical parameters will be monitored for each sample at each monitoring event including:

- temperature;
- dissolved oxygen;
- redox potential;
- pH; and
- electrical conductivity.

QA/QC samples will also be taken in accordance with the Department of Environment's requirements.

**Guide to Abbreviations**

✓	Where exceedences of the assessment criteria have occurred
●	Where the parameter has been detected but do not exceed assessment criteria
NA	Not Assessed (bore was not monitored as it was not part of the monitoring program at the time)
Dry	Bore was dry at the time of sampling
X	Bore could not be found or was lost due to development
NAn	Not Analysed (parameter not part of the groundwater monitoring program)
Y	Yes, will be monitored for during this monitoring event
N	No, will not be monitored for during this monitoring event
Blank	Parameter was analysed and not detected

Parameter: Heavy Metals / Metalloids (Cu, Ni, Pb, Cr, Fe, Cd, As, Zn, Hg, Se, Mn, Mg, Ba)

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Oct 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA	✓	✓	✓	✓	Y	Y	Y	Y
Parmelia Park	NA	NA	NA	NA	NA	NA		✓	✓		Y	Y	Y	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA	✓	Y	Y	Y	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA		✓			Y	Y	Y	Y
22 Walker Street	NA	NA	NA	NA	NA	NA		✓			Y	Y	Y	Y
71 Daly Street	NA	NA	NA	NA	NA	NA		✓			Y	Y	Y	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA			✓	X	Y	Y	Y	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA			X	X	Y	Y	Y	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA			X	X	Y	Y	Y	Y
<b>Landfill Bores</b>														
MW1		✓						✓	✓	✓	Y	Y	Y	Y
MW2					✓				✓	✓	Y	Y	Y	Y
MW3									✓		Y	Y	Y	Y
MW4											Y	Y	Y	Y
COF2	✓							✓		✓	Y	Y	Y	Y
COF7	✓	✓		✓	✓			✓	✓	✓	Y	Y	Y	Y
COF 8	✓	✓			✓			✓	✓	✓	Y	Y	Y	Y
COF 9		✓			✓			✓	✓	X	Y	Y	Y	Y
COF 11											Y	Y	Y	Y
COF 12										Dry	Y	Y	Y	Y

**Management Plan – South Fremantle Landfill Site – FINAL**

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Oct 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
COF 13										✓	Y	Y	Y	Y
SE1					✓			Dry	Dry	Dry	Y	Y	Y	Y
SE2					✓			✓	Dry	Dry	Y	Y	Y	Y
Off-site Bores														
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA	✓	Y	Y	Y	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA	✓	Y	Y	Y	Y

Parameter: TPH

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Oct 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
Parmelia Park	NA	NA	NA	NA	NA	NA		●			Y	Y	Y	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA			●		Y	Y	Y	Y
22 Walker Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
<b>Landfill Bores</b>														
MW1	●	NAn		NAn	NAn	●	●			✓	Y	Y	Y	Y
MW2	●	NAn		NAn	NAn	●					Y	Y	Y	Y
MW3	●	NAn		NAn	NAn	●					Y	Y	Y	Y
MW4		NAn		NAn	NAn						Y	Y	Y	Y
COF2		NAn		NAn	NAn	●	●		✓	✓	Y	Y	Y	Y
COF7		NAn		NAn	NAn	●					Y	Y	Y	Y
COF 8		NAn		NAn	NAn	●	●		✓	✓	Y	Y	Y	Y
COF 9		NAn		NAn	NAn	●					Y	Y	Y	Y
COF 11	●	NAn		NAn	NAn						Y	Y	Y	Y

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Oct 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
COF 12		NAn		NAn	NAn						Y	Y	Y	Y
COF 13		NAn		NAn	NAn						Y	Y	Y	Y
SE1		NAn		NAn	NAn	●			Dry	Dry	Y	Y	Y	Y
SE2		NAn		NAn	NAn				Dry	Dry	Y	Y	Y	Y
<b>Off-site Bores</b>														
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y

Parameter: PAH

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Oct 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
Parmelia Park	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
22 Walker Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
<b>Landfill Bores</b>														
MW1	NAn	NAn		NAn	NAn						Y	Y	Y	Y
MW2	NAn	NAn		NAn	NAn						Y	Y	Y	Y
MW3	NAn	NAn		NAn	NAn						Y	Y	Y	Y
MW4	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF2	NAn	NAn		NAn	NAn			✓			Y	Y	Y	Y
COF7	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF 8	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF 9	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF 11	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF 12	NAn	NAn		NAn	NAn						Y	Y	Y	Y



Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Oct 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
COF 13	NAn	NAn		NAn	NAn						Y	Y	Y	Y
SE1	NAn	NAn		NAn	NAn				Dry	Dry	Y	Y	Y	Y
SE2	NAn	NAn		NAn	NAn				Dry	Dry	Y	Y	Y	Y
<b>Off-site Bores</b>											Y	Y	Y	
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y

Parameter: BTEX

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Oct 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
Parmelia Park	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
22 Walker Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
<b>Landfill Bores</b>														
MW1	●	NAn		NAn	NAn						Y	Y	Y	Y
MW2		NAn		NAn	NAn						Y	Y	Y	Y
MW3		NAn		NAn	NAn						Y	Y	Y	Y
MW4		NAn		NAn	NAn				✓		Y	Y	Y	Y
COF2	●	NAn		NAn	NAn	✓				✓	Y	Y	Y	Y
COF7		NAn		NAn	NAn						Y	Y	Y	Y
COF 8		NAn		NAn	NAn						Y	Y	Y	Y
COF 9		NAn		NAn	NAn						Y	Y	Y	Y
COF 11		NAn		NAn	NAn						Y	Y	Y	Y
COF 12		NAn		NAn	NAn						Y	Y	Y	Y
COF 13		NAn		NAn	NAn						Y	Y	Y	Y

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Oct 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
SE1		NAn		NAn	NAn				Dry	Dry	Y	Y	Y	Y
SE2		NAn		NAn	NAn				Dry	Dry	Y	Y	Y	Y
<b>Off-site Bores</b>														
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y

Parameter: Phenols

Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
Parmelia Park	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
22 Walker Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
<b>Landfill Bores</b>											Y	Y	Y	
MW1		NAn		NAn	NAn						Y	Y	Y	Y
MW2		NAn		NAn	NAn						Y	Y	Y	Y
MW3		NAn		NAn	NAn		✓	✓			Y	Y	Y	Y
MW4		NAn		NAn	NAn						Y	Y	Y	Y
COF2		NAn		NAn	NAn						Y	Y	Y	Y
COF7		NAn		NAn	NAn						Y	Y	Y	Y
COF 8		NAn		NAn	NAn						Y	Y	Y	Y
COF 9		NAn		NAn	NAn						Y	Y	Y	Y
COF 11		NAn		NAn	NAn						Y	Y	Y	Y
COF 12		NAn		NAn	NAn						Y	Y	Y	Y
COF 13		NAn		NAn	NAn						Y	Y	Y	Y

Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
SE1		NAn		NAn	NAn						Y	Y	Y	Y
SE2		NAn		NAn	NAn						Y	Y	Y	Y
SE3							✓				Y	Y	Y	Y
<b>Off-site Bores</b>											Y	Y	Y	
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y

Parameter: OC/OP

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
Parmelia Park	NA	NA	NA	NA	NA	NA					N	Y	N	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
22 Walker Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
<b>Landfill Bores</b>														
MW1	NAn	NAn		NAn	NAn						N	Y	N	Y
MW2	NAn	NAn		NAn	NAn						N	Y	N	Y
MW3	NAn	NAn		NAn	NAn						N	Y	N	Y
MW4	NAn	NAn		NAn	NAn						N	Y	N	Y
COF2	NAn	NAn		NAn	NAn						N	Y	N	Y
COF7	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 8	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 9	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 11	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 12	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 13	NAn	NAn		NAn	NAn						N	Y	N	Y

Bore	Monitoring event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
SE1	NAn	NAn		NAn	NAn						N	Y	N	Y
SE2	NAn	NAn		NAn	NAn						N	Y	N	Y
<b>Off-site Bores</b>														
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y

**Parameter: Triazine Pesticides**

Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
Parmelia Park	NA	NA	NA	NA	NA	NA					N	Y	N	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
22 Walker Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
<b>Landfill Bores</b>														
MW1	NAn	NAn		NAn	NAn						N	Y	N	Y
MW2	NAn	NAn		NAn	NAn						N	Y	N	Y
MW3	NAn	NAn		NAn	NAn						N	Y	N	Y
MW4	NAn	NAn		NAn	NAn						N	Y	N	Y
COF2	NAn	NAn		NAn	NAn						N	Y	N	Y
COF7	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 8	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 9	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 11	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 12	NAn	NAn		NAn	NAn						N	Y	N	Y
COF 13	NAn	NAn		NAn	NAn						N	Y	N	Y



Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
SE1	NAn	NAn		NAn	NAn						N	Y	N	Y
SE2	NAn	NAn		NAn	NAn						N	Y	N	Y
<b>Off-site Bores</b>														
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y

Parameter: PCBs

Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
Parmelia Park	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
22 Walker Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
<b>Landfill Bores</b>											Y	Y	Y	Y
MW1	NAn	NAn		NAn	NAn						Y	Y	Y	Y
MW2	NAn	NAn		NAn	NAn						Y	Y	Y	Y
MW3	NAn	NAn		NAn	NAn						Y	Y	Y	Y
MW4	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF2	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF7	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF 8	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF 9	NAn	NAn		NAn	NAn				✓		Y	Y	Y	Y
COF 11	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF 12	NAn	NAn		NAn	NAn						Y	Y	Y	Y
COF 13	NAn	NAn		NAn	NAn						Y	Y	Y	Y

Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
SE1	NAn	NAn		NAn	NAn						Y	Y	Y	Y
SE2	NAn	NAn		NAn	NAn						Y	Y	Y	Y
<b>Off-site Bores</b>											Y	Y	Y	
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y

**Parameter: Fatty Acids (Organic Acids)**

Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
Parmelia Park	NA	NA	NA	NA	NA	NA					N	Y	N	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
22 Walker Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					N	Y	N	Y
<b>Landfill Bores</b>														
MW1	NAn	NAn		●			NAn				N	Y	N	Y
MW2	NAn	NAn		●			NAn				N	Y	N	Y
MW3	NAn	NAn					NAn				N	Y	N	Y
MW4	NAn	NAn					NAn				N	Y	N	Y
COF2	NAn	NAn		●			NAn				N	Y	N	Y
COF7	NAn	NAn		●			NAn				N	Y	N	Y
COF 8	NAn	NAn					NAn				N	Y	N	Y
COF 9	NAn	NAn					NAn				N	Y	N	Y
COF 11	NAn	NAn					NAn				N	Y	N	Y
COF 12	NAn	NAn					NAn				N	Y	N	Y
COF 13	NAn	NAn					NAn				N	Y	N	Y

Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
SE1	NAn	NAn					NAn				N	Y	N	Y
SE2	NAn	NAn					NAn				N	Y	N	Y
<b>Off-site Bores</b>														
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		N	Y	N	Y

**Parameter: Pathogen Analyses (E-coli and Bacteria Counts)**

Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
<b>Private Bores</b>														
61 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
Parmelia Park	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
30 Hickory Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
9 Duoro Road	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y
20 Commercial Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
22 Walker Street	NA	NA	NA	NA	NA	NA			●		Y	Y	Y	Y
71 Daly Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
32 Duoro Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
10 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Thomas Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
8 Newmarket Street	NA	NA	NA	NA	NA	NA					Y	Y	Y	Y
<b>Landfill Bores</b>														
MW1		NAn	✓		●						Y	Y	Y	Y
MW2		NAn			●						Y	Y	Y	Y
MW3		NAn									Y	Y	Y	Y
MW4		NAn									Y	Y	Y	Y
COF2		NAn	✓		●						Y	Y	Y	Y
COF7		NAn			●						Y	Y	Y	Y
COF 8		NAn			●						Y	Y	Y	Y
COF 9		NAn	✓		●						Y	Y	Y	Y
COF 11		NAn									Y	Y	Y	Y
COF 12		NAn									Y	Y	Y	Y

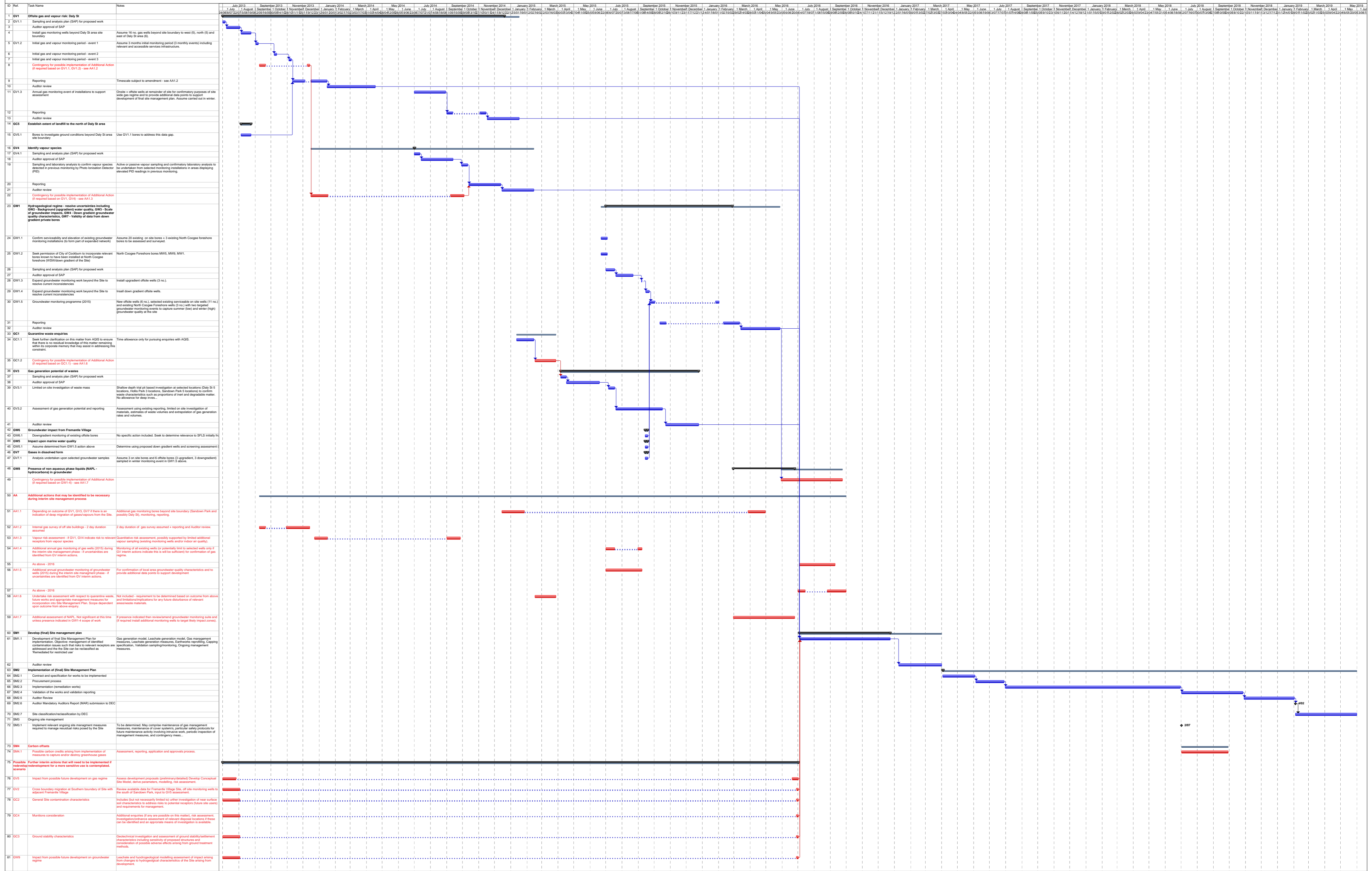
Bore	Monitoring Event													
	May 99	Nov 99	March 00	Sept 00	March 01	Sept 01	March 02	Sept 02	March 03	Oct 03	March 04	Sept 04	March 05	Sept 05
COF 13		NAn									Y	Y	Y	Y
SE1		NAn			●						Y	Y	Y	Y
SE2		NAn						●			Y	Y	Y	Y
<b>Off-site Bores</b>														
BH1	NA	NA	NA	NA	NA	NA	NA	NA	NA	●	Y	Y	Y	Y
BH2	NA	NA	NA	NA	NA	NA	NA	NA	NA		Y	Y	Y	Y

# Appendix C

## Proposed Timeline – Interim Actions



**South Fremantle Landfill Site**  
Interim Site Management Actions - Indicative programme



- 4 **Initial gas monitoring wells beyond Daily St area site boundary**  
Assume 10 no. gas wells beyond site boundary to west (5), north (5) and east of Daily St area (6).
- 5 **Initial gas and vapour monitoring period - event 1**  
Assume 3 months initial monitoring period (3 monthly events) including relevant and accessible services infrastructure.
- 9 **Reporting**  
Timescale subject to amendment - see A&L 2
- 11 **Annual gas monitoring event of installations to support assessment**  
Onsite - offsite wells at remainder of site for confirmatory purposes of site wide gas regime and to provide additional data points to support development of final site management plan. Assume carried out in winter.
- 15 **Bore to investigate ground conditions beyond Daily St area site boundary**  
Use GVS 1 bores to address this data gap.
- 19 **Sampling and laboratory analysis to confirm vapour species detected in previous monitoring by Photo Ionisation Detector (PID)**  
Active or passive vapour sampling and confirmatory laboratory analysis to be undertaken from selected monitoring installations in areas displaying elevated PID readings in previous monitoring.
- 24 **Confirm serviceability and elevation of existing groundwater monitoring installations (to form part of expanded network)**  
Assume 20 existing on site bores + 3 existing North Coogee foreshore bores to be assessed and surveyed.
- 25 **Seek permission of City of Cockburn to incorporate relevant bores known to have been installed at North Coogee foreshore (W&W down gradient of the Site)**  
North Coogee Foreshore bores MW5, MW6, MW7.
- 28 **Expand groundwater monitoring work beyond the Site to resolve current inconsistencies**  
Install upgradient offsite wells (3 no.).
- 29 **Expand groundwater monitoring work beyond the Site to resolve current inconsistencies**  
Install down gradient offsite wells.
- 30 **Groundwater monitoring programme (D16)**  
New offsite wells (6 no.), selected existing serviceable on site wells (11 no.) and existing North Coogee Foreshore wells (3 no.) with two targeted groundwater monitoring events to capture summer (low) and winter (high) groundwater quality at the site.  
Time allowance only for purging enquiries with A&L.
- 39 **Limited on site investigation of waste mass**  
Shallow depth trial pit based investigation at selected locations (Daily St 5 locations, Hollis Park 3 locations, Sandown Park 5 locations) to confirm waste characteristics such as proportions of inert and degradable matter. No allowance for deep investigation.
- 40 **Assessment of gas generation potential and reporting**  
Assessment using existing reporting, limited on site investigation of materials, estimates of waste volumes and extrapolation of gas generation rates and volumes.
- 43 **Downgradient monitoring of existing offsite bores**  
No specific action included. Seek to determine relevance to SFLS initially from GW1 actions (downgradient monitoring of North Coogee Foreshore bores MW1, MW5, MW6).
- 45 **Assume determined from GW1.5 action above**  
Determine using proposed down gradient wells and screening assessment (comparison of groundwater quality characteristics with relevant assessment criteria).
- 47 **Analysis undertaken upon selected groundwater samples**  
Assume 3 on site bores and 6 offsite bores (3 upgradient, 3 downgradient) sampled in winter monitoring event in GW1.5 above.
- 51 **Depending on outcome of GW1, GW3, GW7 if there is an indication of deep migration of gases/vapours from the Site.**  
Additional gas monitoring bores beyond site boundary (Sandown Park and possibly Daily St), monitoring, reporting.
- 52 **Interim gas survey of off site buildings - 2 day duration assumed**  
3 day duration of gas survey assumed + reporting and Auditor review.
- 53 **Vapour risk assessment - if GW1, GW4 indicate risk to relevant receptors from vapour species**  
Quantitative risk assessment, possibly supported by limited additional vapour sampling (existing monitoring wells and/or indoor air quality).
- 54 **Additional annual gas monitoring of gas wells (D16) during the interim site management phase - if uncertainties are identified from GW interim actions.**  
Monitoring of all existing wells (or potentially limit to selected wells only if GW interim actions indicate this is well be sufficient) for confirmation of gas regime.
- 56 **Additional annual groundwater monitoring of groundwater with (D16) during the interim site management phase - if uncertainties are identified from GW interim actions.**  
For confirmation of local area groundwater quality characteristics and to provide additional data points to support development.
- 58 **Undertake risk assessment with respect to groundwater, future works and appropriate management measures for incorporation into Site Management Plan. Scope dependent upon outcome from above enquiry.**  
Not included - requirement to be determined based on outcome from above and limitations/implications for any future disturbance of relevant areas/waste materials.
- 59 **Additional assessment of MAR. Not significant at this time unless previous indicated in GW1.4 scope of work**  
If presence indicated then review/amend groundwater monitoring suite and if required install additional monitoring wells to target likely impact zones).
- 61 **Development of final Site Management Plan for implementation. Objective: management of identified contamination issues such that risks to relevant receptors are addressed and the Site can be reclassified as 'Remediated for restricted use'**  
Gas generation model, Leachate generation model, Gas management measures, Leachate generation measures, Earthworks reprofiling, Capping specification, Validation sampling/monitoring, Ongoing management measures.
- 72 **Implement relevant ongoing site management measures required to manage residual risks posed by the Site**  
To be determined. May comprise maintenance of gas management measures, maintenance of cover system/s, particular safety protocols for future maintenance activity involving intrusive work, periodic inspection of management measures, and contingency measures.
- 74 **Possible carbon credits arising from implementation of measures to capture and/or destroy greenhouse gases**  
Assessment, reporting, application and approvals process.
- 76 **Impact from possible future development on gas regime**  
Assess development proposal (preliminary/detailed) Develop Conceptual Site Model, derive parameters, modelling, risk assessment.
- 77 **Cross boundary migration at Southern boundary of Site with adjacent Fremantle Village**  
Review available data for Fremantle Village Site, off site monitoring wells to the south of Sandown Park, input to GVS assessment.
- 79 **General site contamination characteristics**  
Includes (but not necessarily limited to) further investigation of near surface soil characteristics to address risks to potential receptors (future site users) and requirements for management.
- 80 **Manholes consideration**  
Additional enquiries (if any are possible on this matter), risk assessment, investigation/ordnance assessment of relevant disposal locations (if these can be identified and an appropriate means of investigation is available).
- 81 **Ground stability characteristics**  
Geotechnical investigation and assessment of ground stability/settlement characteristics including sensitivity of proposed structures and consideration of possible adverse effects arising from ground treatment methods.
- 82 **Impact from possible future development on groundwater regime**  
Leachate and hydrogeological modelling assessment of impact arising from changes to hydrogeological characteristics of the Site arising from development.



GHD

GHD House, 239 Adelaide Tce. Perth, WA 6004  
P.O. Box 3106, Perth WA 6832  
T: 61 8 6222 8222 F: 61 8 6222 8555 E: permail@ghd.com.au

© GHD 2013

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

\\ghdnet\ghd\AU\Perth\Projects\61\29215\WP\130800.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	S French	D Todd	On file	D Todd	On file	03/04/2013

[www.ghd.com](http://www.ghd.com)

