Hampshire Water Transfer and Water Recycling Project

Environmental Statement - Appendix 11.2 Geotechnical and geo-environmental reports- 12 of 18 documents - Geo-Environmental Interpretative Report – Proposed Water Recycling Plant

VOLUME NUMBER: 6

PLANNING INSPECTORATE SCHEME NUMBER: WA010002

APPLICATION DOCUMENT REFERENCE: 6.2

APFP REGULATION: 5(2)(a)

May 2026

Version 0

from Southern Water

Contents

1 Introduction

1.1 Preamble

Strategic Solutions Partner (SSP) has been instructed by Southern Water Services Limited (hereafter referred to as ‘the Applicant’) to prepare a Geo-Environmental Interpretative Report summarising the ground conditions within a parcel of land to the north of Harts Farm Way (the Site, also known as Land Parcel 72 [LP72]).

In 2021 SSP was appointed by the Applicant as part of their Water for Life Western Grid Project in Hampshire, to produce a Geo-environmental Desk Study for the Site to inform the ‘reference design’ of the proposed Water Recycling Plant site (WRP).

This report presents a Geo-Environmental Interpretative Report comprising a desk study, Tier 1 (preliminary) qualitative contamination risk assessment and a Tier 2 (generic quantitative) risk assessment.

1.2 Context and Objective

This report has been prepared in a planning context (rather than a Part 2A statutory contaminated land context).

In preparing this report Stantec has considered the requirements of the National Planning Policy Framework (NPPF) (MHCLG, 2021) in respect of ground conditions and in particular paragraph 183 which states:

“*Planning policies and decisions should ensure that:*

a) *a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);*
b) *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and,*
c) *adequate site investigation information, prepared by a competent person, is available to inform these assessments*”.

The objective of this report is to identify the likely ground conditions using published and publicly available information (see below for sources of information accessed) and to assess whether there are contamination risks associated with the ground conditions that require management (remediation or mitigation).

1.3 Methodology

The following summarises the ground conditions assessment methodology adopted by SSP with a more detailed description in our guide entitled Stantec Guide: Methodology for Assessment of Land Contamination (England), a copy of which is presented in **Appendix A**.

1.3.1 Assessment of Ground Conditions – Contamination

As required by the NPPF this assessment has been carried out in accordance with "*established procedures*". Our methodology follows guidance on how to assess and manage the risks from land contamination given in "Land Contamination Risk Management" (LCRM) (EA, 2023).

The principal planning objective in respect of contamination is to ensure that any unacceptable risks to human health, buildings and other property and the natural and historical environment from the contaminated condition of the land are identified so that appropriate action can be considered and taken to address those risks.

LCRM presents a three-stage process to the management of contaminated land:

- Stage 1 = Risk assessment,
- Stage 2 = Options appraisal, and
- Stage 3 = Remediation.

The Stage 1 risk assessment is undertaken in a phased manner comprising three tiers, with the three tiers being:

- Tier 1 – "Preliminary Risk Assessment" – a qualitative assessment forming part of a Phase 1 report,
- Tier 2 – "Generic Risk Assessment" - a quantitative assessment using published criteria to screen site specific ground condition data forming part of a Phase 2 report and
- Tier 3 – "Detailed Risk Assessment" – a quantitative assessment involving the generation of site-specific assessment criteria (SSAC).

1.4 Report Format

This report begins with a summary of the Site's land-use history and environmental setting and presents a Tier 1 (Preliminary) risk assessment. It then progresses to an interpretative review of the ground conditions and geo-environmental conditions at the Site, as evidenced by an intrusive Ground Investigation (GI) undertaken by Delta-Simons in 2021[1] and presents a Tier 2 (Generic) risk assessment, followed by an outline remediation strategy.

1.5 Sources of Information

The following sources of information were used in the preparation of this report:

- A Geo-Environmental Desk Study for the Site and other land parcels in the site's immediate vicinity, prepared by SSP in November 2021 (SSP, 2021). This desk study was itself informed by a review of many of the historical reports listed below, as well as a Groundsure Geo and Enviro Insight Report (Groundsure Ltd., 2021) that includes historical Ordnance Survey (OS) maps and aerial photographs, information on waste and landfill sites, current and recent industrial activity, hydrogeology, hydrology,

[1] The Applicant has obtained reliance on this ground investigation in November 2022 via a Letter of Reliance from Delta Simons

environmental designations, habitats designations and information on ecologically sensitive sites and geology (basic).

- Geology maps and borehole records held by the British Geological Survey and accessed via their website (BGS, 2023) and Geological Survey of Great Britain (England and Wales) 1:63,360/1:50,000 geological map series.
- Imagery available on Google Earth ('street view' and aerial images).
- A "Phase 2 Geo-Environmental Investigation Report" prepared by White Young Green (WYG) for the Site in August 2017 (White Young Green, 2017). WYG's report includes the findings of a ground investigation undertaken at the Site in March 2017.
- A Factual Geo-Environmental Investigation Report prepared by DS for the Site in July 2021 (Delta Simons, 2021). Reliance on the digital ground investigation information supporting DS's assessment was purchased by the Applicant.
- An interpretative Geo-Environmental Assessment prepared by DS in January 2022 (Version 4) for the Site (Delta Simons, 2022).
- A "Remediation Options Appraisal and Verification Strategy" prepared by DS in January 2022 (Delta Simons, 2022b).
- Information and drawings provided by Havant Borough Council's Environmental Health department (a copy of which is provided in **Appendix B**).
- Information provided by the Environment Agency, a copy of which is provided in **Appendix C**.
- Historical aerial photographs of the Site available through Historic England's Aerial Photo Explorer (Historic England, 2023) and the University of Cambridge's Air Photos Archive (University of Cambridge, 2023).
- A "Report on Site Investigation for Proposed Urban Development – Phase One, Proposed Refuse Tip Storehouse Lake", prepared by Structural Soils Ltd. on behalf of Havant and Waterloo Urban District Council in August 1967 (Structural Soils Ltd., 1967).
- The factual report for a ground investigation undertaken at the Site by SOCOTEC during 2022 to inform the design of the tunnels and shafts leading to the Site from Budds Farm WWTW (SOCOTEC, 2023).

1.6 Limitations

This report has been prepared within an agreed timeframe and to an agreed budget that will necessarily apply some constraints on its content and usage. The remarks below are presented to assist the reader in understanding the context of this report and any general limitations or constraints. If there are any specific limitations and constraints, they are described in the report text.

The opinions and recommendations expressed in this report are based on statute, guidance, and best practice current at the time of its publication. Stantec UK Ltd (Stantec) does not accept any liability whatsoever for the consequences of any future legislative changes or the release of subsequent guidance documentation, etc. Such changes may render some of the opinions and advice in this report inappropriate or incorrect and the report should be returned to us and reassessed if required for re-use after one year from date of publication. Following delivery of the report, Stantec has no obligation to advise the Client or any other party of such changes or their repercussions.

Some of the conclusions in this report may be based on third party data. No guarantee can be given for the accuracy or completeness of any of the third-party data used.

Historical maps and aerial photographs provide a "snapshot" in time about conditions or activities at the site and cannot be relied upon as indicators of any events or activities that may have taken place at other times. It is possible for developments to have occurred between surveys that are not shown or for the map record to have been censored for military security.

The conclusions and recommendations made in this report and the opinions expressed are based on the information reviewed and/or the ground conditions encountered in exploratory holes and the results of any field or laboratory testing undertaken. There may be ground conditions at the site that have not been disclosed by the information reviewed or by the investigative work undertaken. Such undisclosed conditions cannot be considered in any analysis and reporting.

It should be noted that this report is a land condition assessment and does not purport to be an ecological, flood risk or archaeological survey and additional specific surveys may be required.
The identification of invasive and/or noxious plants such as Japanese Knotweed is outside the remit of our appointment.

This report has been written for the sole use of the Client stated at the front of the report in relation to a specific development or scheme. The conclusions and recommendations presented herein are only relevant to the scheme or the phase of project under consideration. This report shall not be relied upon or transferred to any other party without the expressed written authorisation of Stantec. Any such party relies upon the report at its own risk.

The interpretation carried out in this report is based on scientific and engineering appraisal carried out by suitably experienced and qualified technical consultants based on the scope of our engagement. We have not considered the perceptions of, for example, banks, insurers, other funders, lay people, etc., unless the report has been prepared specifically for that purpose. Advice from other specialists may be required such as the legal, planning and architecture professions, whether specifically recommended in our report or not.

Public or legal consultations or enquiries, or consultation with any Regulatory Bodies (such as the Environment Agency, Natural England or Local Authority) have taken place only as part of this work where specifically stated.

2 Site Location and Description

2.1 Site Location

The Site is located approximately 1.4 km south-west of the centre of Havant and approximately 300 m west of Budds Farm Wastewater Treatment Works (WTW) and may be located by NGR 470140E, 105670N, as shown on **Figure 1**, Site Location Plan.

2.2 Site Description

The Site occupies an area of approximately 7.9 ha and is accessed via a gated entrance off Harts Farm Way to the south.

A review of historical reports and information provided by both the Environment Agency and Havant Borough Council indicates that the Site comprises a former landfill (Harts Farm Way) that had been restored to grassland and is fringed with woodland. A hard-surfaced former access road/yard is present in the centre of the Site, connected to Harts Farm Way to the south by an access road.

A review of the topographic survey of the Site (Greenhatch Group, 2020) indicates that the eastern and western halves of the Site have very different topography:

- The western half of the Site is occupied by a plateau that is approximately level, with a slight fall from the north-western corner at approximately 10.5 m Above Ordnance Datum (AOD) to a low of approximately 9.0 m AOD on the southern boundary near the access road at the southern boundary. The plateau appears to be raised by between approximately 0.5 m and 3.0 m above the surrounding ground levels.
- The eastern half of the Site is occupied by a domed landform with a peak of approximately 15.2 m AOD. The land falls in all directions from the peak to approximately 10 m AOD on the northern boundary, 9.5 m AOD on the eastern boundary, 7.5 m AOD on the southern boundary and 8.5 m AOD at the eastern edge of the yard in the centre of the Site.

Beyond the Site, the land falls towards the east to the Hermitage Stream and the south towards Langstone Harbour (noting that the topography of the land immediately surrounding the Site is not natural and comprises reclaimed land).

Land use in the surrounding area is described as follows:

- North: The A27, beyond which (approximately 80 m north) is undeveloped agricultural land.
- East: The site's eastern boundary is formed by woodland, beyond which is a public footpath adjacent to the Hermitage Stream. Beyond the stream (approximately 60 m east of the Site) is an aggregates wharf, a business centre and depot, the Havant household waste recycling centre, and various commercial / light industrial units.
- South and West: Harts Farm Way, immediately beyond which are further restored landfill cells. Approximately 200 m to the south of the Site (beyond the other areas of landfill) is Langstone Harbour, an inlet of the English Channel.

2.3 Proposed Development

The Proposed Development for which consent is sought comprises:

- Proposed WRP in the vicinity of Budds Farm Wastewater Treatment Works (WTW) with a total peak output of approximately 60 Ml/d of recycled water. The proposed WRP would receive approximately 80 Ml/d of treated wastewater to produce a total peak output of approximately 60 Ml/d of recycled water. During normal (i.e. non peak/drought) operation, the output of the proposed WRP is expected to be approximately 20 Ml/d depending on water availability at Bedhampton Springs. There would be three pumping stations at the site including the proposed High Lift Pumping Station (HLPS).
- Proposed Underground Pipeline to transfer at peak operation (i.e. during severe drought conditions) approximately 90 Ml/d of water from Havant Thicket Reservoir to Otterbourne Water Supply Works (WSW) via the proposed HLPS. During normal (i.e. non peak/drought) operation, the pipeline would transfer at least 20Ml/d of water from Havant Thicket Reservoir to Otterbourne WSW.
- Proposed Underground Pipelines between Budds Farm WTW and the proposed WRP to accommodate approximately 80 Ml/d peak transfer volumes in each direction.
- Proposed Pipeline to transfer at peak operation approximately 60 Ml/d of recycled water from the proposed WRP to Havant Thicket Reservoir.
- Proposed additional Above Ground Plant (AGP) comprising Intermediate Pumping Stations (IPS) and Break Pressure Tanks (BPT) located along the proposed Underground Pipeline between Havant Thicket Reservoir and Otterbourne WSW.

The land parcel within which the proposed WRP to be constructed (the Site) is also referred to as WRP_72. The location of the proposed WRP is shown on Figure 1 and the current layout of the Site is shown on Figure 2 (Site Layout Plan).

This Report relates solely to elements of the Proposed Development relating to the proposed WRP, including:

- New buildings, tanks, infrastructure and foundations at the WRP.
- The South Shaft - launch shaft at the WRP for the Budds Farm tunnel.
- The East Shaft - a launch shaft at the WRP for the Havant Thicket Reservoir tunnel or Bedhampton Springs tunnel (final route to be confirmed).
- The West Shaft - a launch shaft at the WRP for the Purbrook tunnel.

The proposed WRP is expected to consist of a main process building, kiosks for control equipment, administration buildings and parking facilities. Several large holding tanks and chemical storage units would be required for operation of the proposed WRP.

Other interpretative Ground Investigation Reports (GIRs) are being prepared to address different elements of the Proposed Development.

2.4 Piling

The WRP would be supported on piled foundations. For lightly loaded slabs or hardstanding, piles would be socketed approximately 2 m into the top of the Chalk (approx. total 15 m depth). For heavier structures piles would be extended approximately 8 m into the Chalk (approx. 21 m total depth).

Continuous Flight Auger (CFA) piles are the current preferred option. CFA piles are constructed by rotating a hollow stem continuous flight auger into the soil to a designed depth. Concrete or grout is pumped through the hollow stem, maintaining static head pressure, to fill the cylindrical cavity created as the auger is slowly removed. The reinforcement cage is placed through the freshly placed concrete. This cast in-situ method ensures 'intimate contact' between the pile and the surrounding landfill waste, minimising the risk of creating pathways for contamination to migrate into the underlying Chalk and adjacent surface waters.

It is recognised that there are particular difficulties associated with installing CFA piles within a landfill. These could include:

- If the landfill is very incompetent (i.e. undrained shear strength <30kPa) there is a risk that the material surrounding the pile may collapse into the concrete mix before the concrete is set. It is possible to use a casing to support the bore, which is then withdrawn following the concrete pour. Following withdrawal of the casing, it is imperative that the material surrounding the pile does not collapse into the wet concrete. To combat this the concrete mix would be thickened, however there is a limit to how thick the mix can be made due to the requirement to insert the steel reinforcement prior to setting.
- There is the potential for obstructions to be present within the landfill waste which could be difficult to overcome with CFA. If the challenges cannot be resolved, an alternate boring method might instead be used. Regardless of boring method, a cast in-situ pile will be used.
- Design Sulphate (DS) Class and Aggressive Chemical Environment for Concrete (ACEC) conditions might impact the decision on whether CFA is feasible. Should the waste materials be classified to be AC-4 or above, challenges might arise around the concrete coverage required around the reinforcement cage. If this is the case, the pile diameter can be increased to allow for sacrificial concrete.

2.5 Shaft Construction

Three launch shafts will be constructed within WRP_72 to enable pipeline tunnelling by Tunnel Boring Machine (TBM) or pipe-jacking:

- WRP_72 East shaft (launch shaft for one of two tunnel alternatives below)
    - a. Bedhampton Pipe-Jack (preferred option)
        - i. Shaft internal diameter 12.5m
        - ii. Tunnel invert level 16.8mbgl
    - b. or Havant Tunnel (excavated by TBM)
        - i. Shaft Internal diameter 15.0m
        - ii. Tunnel Invert level 28.9mbgl

- WRP_72 West shaft – for Purbrook Tunnel (excavated by TBM)
    - i. Shaft Internal diameter 15.0m
    - ii. Tunnel Invert level 24.6mbgl

- WRP_72 South shaft – for Budds Farm Pipe-Jack
    - i. Shaft Internal diameter 9.0m
    - ii. Tunnel Invert level 20.4mbgl

All shafts will descend through Landfill Waste, then Quaternary superficial deposits including Alluvium, Raised Marine Beach Deposits and River Terrace Deposits (one or more of these) and reach their full depth in the Chalk below, which may be structured/structureless.

According to the current proposed designs, all shafts will be constructed using non-displacement methods, which limits the opportunity for waste to be pushed into the surrounding natural deposits/aquifers. The shafts will comprise a diaphragm wall (primary lining), with a cast-in-situ, reinforced concrete secondary lining, constructed using the following methodology:

1. First, deep soil mixing will be used within the Made Ground and landfill waste to stabilise the ground around the proposed diaphragm wall and prevent instability of the trench, as well as substantially lowering the permeability of the soils, preventing migrating of contamination. A more stable trench will lead to smooth-sided diaphragm walls, thus ensuring intimate contact between the poured concrete and the surrounding soils. This intimate contact prevents new contamination pathways forming at the soil-concrete interface. Deep soil mixing is an in-situ ground improvement technique that enhances the characteristics of weak soils by mechanically mixing them with a cementitious binder injected into the soil. The action of mixing materials such as cement or bentonite with soil causes the properties of the soil to become more like soft rock. It is anticipated that this will be achieved using a wet binder from an on-site temporary batching plant, to create a series of overlapping soil mixed columns. By this method two concentric, stabilised cut-off walls will be formed either side of the proposed diaphragm wall. The inner wall is temporary and is excavated later, with the shaft.

2. Within the deep soil mixing cut off wall a diaphragm wall (primary lining) will be constructed down to the base depth of the shaft (i.e., through the natural soils). A grab excavator will be used to form the excavation for each wall 'panel', with a bentonite slurry used to keep the excavation open, again ensuring smooth-sided diaphragm walls and good contact of the poured concrete with surrounding soil. Once a panel has been excavated, reinforcement cages are lowered into the excavation, after which concrete for that panel is poured.

3. Following the completion of all panels, a capping beam will be cast to control displacements and provide structural continuity between panels.

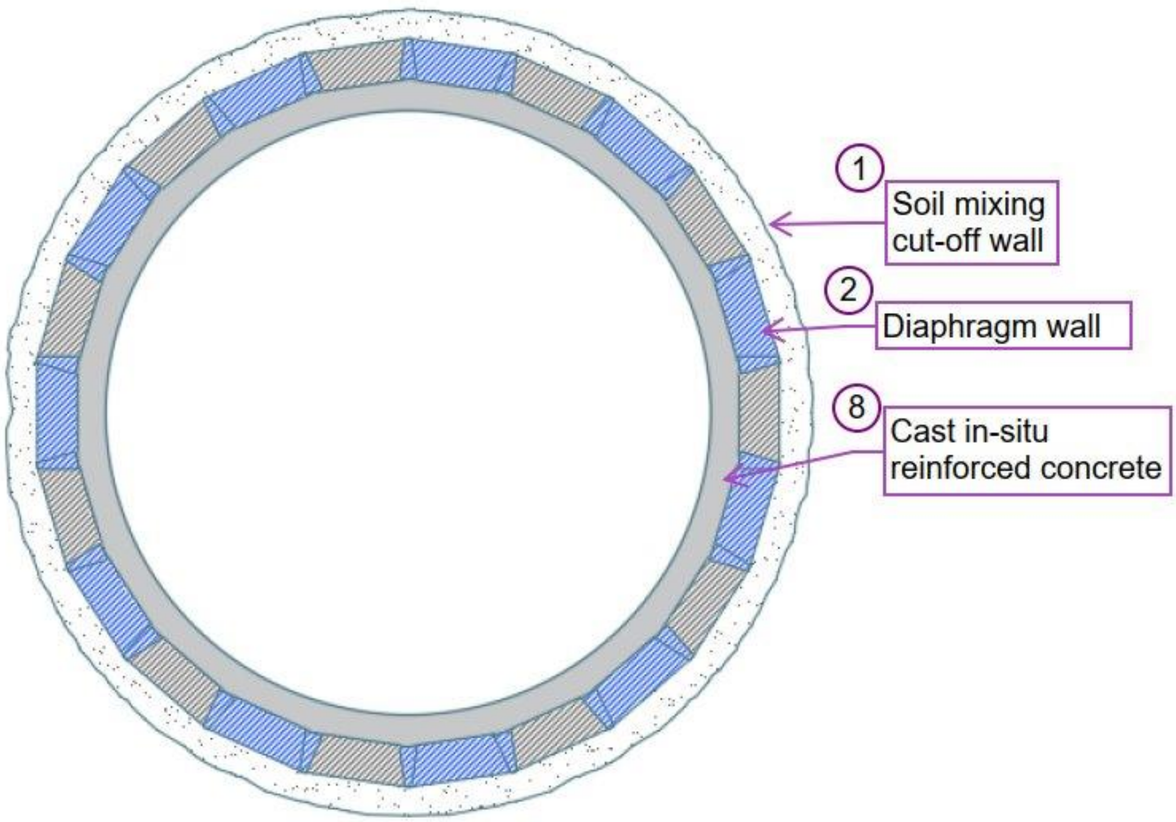
4. The shaft and inner cut-off wall will then be excavated to the full depth, including temporary dewatering prior to casting the base slab. Groundwater inflow will be minimised by embedding diaphragm walls into competent Chalk and fissure grouting (if required) the Chalk beneath the final excavation level. Pump tests will be carried out to monitor the hydrogeological regime and determine the measures necessary for groundwater control.

5. The reinforced concrete base slab is cast.

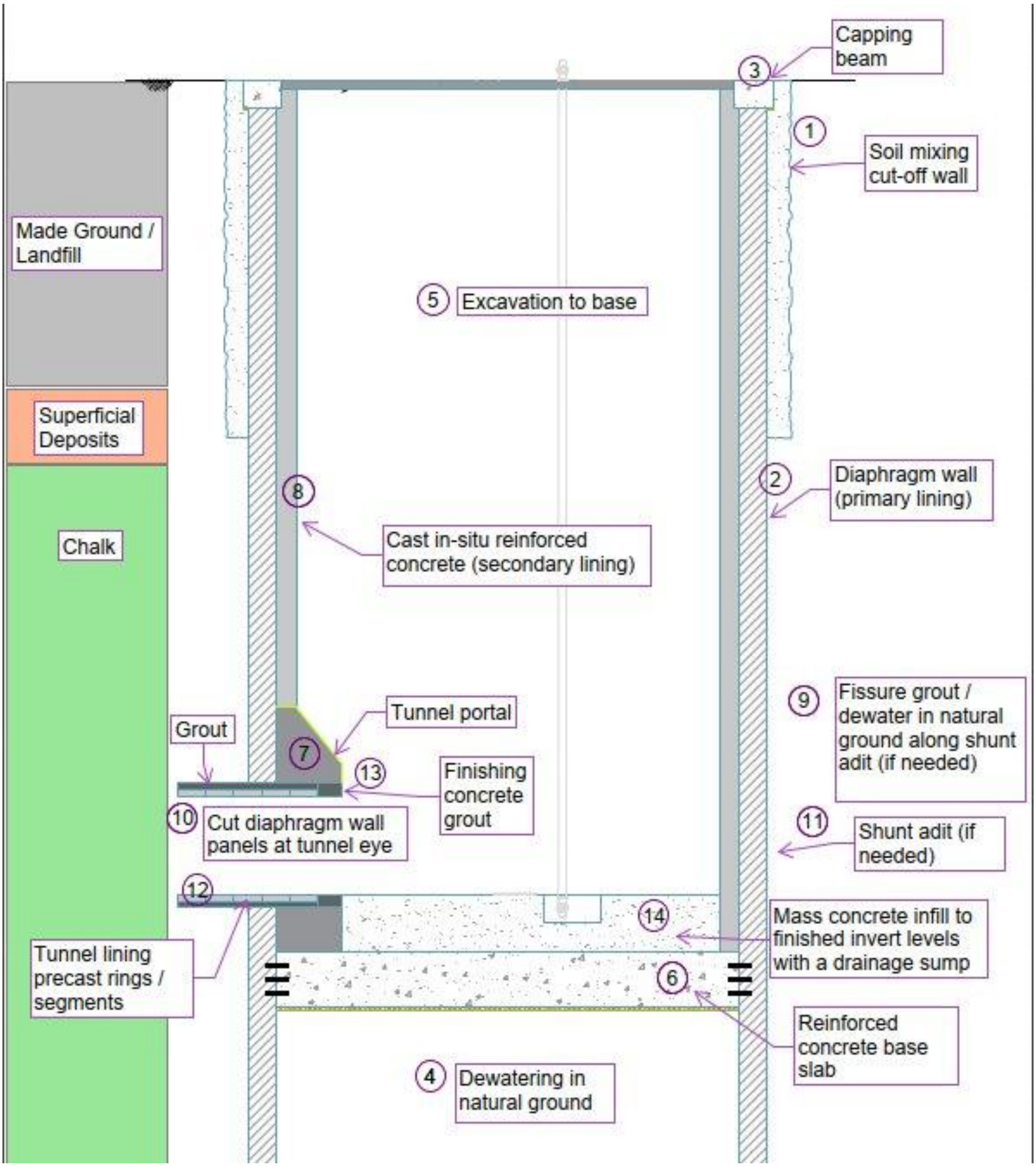
6. A tunnel portal is constructed from reinforced concrete followed by a secondary lining of reinforced concrete around the diaphragm walls, to provide additional water tightness (diaphragm wall panels will be cut later at the tunnel eye as tunnelling proceeds).

The extracts below show a plan view and cross section of the completed shaft.

Extract 1 - Schematic Plan View of Completed Shaft (adapted from Drawing 710166-SWS-XX-XX-DR-C-04263 P01.3)



Extract 2 - Schematic Cross Section of Completed Shaft (adapted from Drawing 710166-SWS-XX-XX-DR-C-04252 P01.3)



3 Site History and Land Use Information

3.1 Land Use Information

This section presents a summary of current and historical land uses on and immediately adjacent to the site. Land use is used to inform the hazard identification element of the risk assessment.

3.2 Current Land Use

The Site is currently vacant and comprises open grassland (restored former landfill) with a hardstanding area in the centre of the Site, connected to Harts Farm Way by an access road.

The land to the east of the hardstanding area rises up into a domed landform, sloping down more steeply towards the northern Site boundary and more gently down towards the southern Site boundary. The landform is vegetated with grass and 'scrubland' plants. Woodland is present along the northern and eastern boundaries. At the eastern boundary, the land begins to fall to the east towards the adjacent Hermitage Stream.

The land to the west of the hardstanding area is grassed and approximately level, with a slight slope to the south. A low 'bund' is present around the edges of the flat, grassed area, beyond which the land is vegetated with trees and shrubs.

At the time of the reconnaissance survey (March 2022) it appeared that vegetation had recently been removed from around the hardstanding area in the centre of the Site, and from around the Site's north-eastern, eastern, and south-eastern boundaries.

An overhead power line crosses across the Site, parallel to the Site's southern boundary.

3.3 Historical Land Use

Pre-Landfilling – Pre 1900s to 1960s

The earliest map available within the Groundsure Report, dated 1866, indicates that the Site comprised undeveloped marshy ground crossed by the Hermitage Stream.

Historical aerial photography available through Historic England's archives (Historic England, 2023) dated 1946 and 1948[2] shows that the land within approximately 40m of the Site's northern boundary appears to be higher-lying and in use for agriculture. Historical mapping records that approximately the western-most 100 m of the site appears to be vegetated and crossed by streams and is labelled as "Broad Marsh". The remainder of the land within the Site appears to comprise marshland and the channel of the Hermitage Stream.

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[2] https://historicengland.org.uk/images-books/archive/collections/aerial-photos/record/raf_106g_uk_1124_rvp4_6335, https://historicengland.org.uk/images-books/archive/collections/aerial-photos/record/raf_58_19_vp1_5010, https://historicengland.org.uk/images-books/archive/collections/aerial-photos/record/raf_3g_tud_uk_156_v_5043,

Landfill Construction and Waste Deposition – 1960s to 1980s

Planning application 14239/G proposed to develop the site through the construction of a "controlled refuse tip to level of surrounding area, with topsoil cover". The date of this application is unclear[3] but appears to have been approved in April 1962, subject to conditions.

Planning permission HWU.14239/3G, dated September 1968 granted permission for "*use of land at Storehouse Lake, Bedhampton, as a controlled tip, quay, slip-way and dinghy park and construction of a channel diversion and road*". A 'red-line' plan showing the extent of this permission is not provided, however it is likely to apply to the area recorded by the Environment Agency (EA) as an historical landfill. Drawing 639/59 (**Appendix B**) shows the location of a proposed bund wall, channel re-alignment works, proposed access road and indicates the areas where "level to be raised by controlled tipping" (appears to be the higher-lying land in the west of the site) and "area to be reclaimed by controlled tipping" (appears to be the lower lying coastal marshland).

Limited information relating to the landfill activities allowed by the planning permission is available within the Schedule of Conditions to the planning permission, as follows:

- *"Refuse shall be tipped in layers not exceeding 6 ft. in depth.*
- *"All refuse exposed to the air shall be covered each day with at least 9 ins. of earth or other suitable inert material capable of forming an effective seal.*
- *"Deposits mainly of animal or fish waste shall be covered forthwith with at least 2 ft. of earth or other suitable inert material capable of forming an effective seal".*
- *"No substance shall be deposited on the land other than the following: i) Soil, chalk, sand, gravel, hardcore and other earth spoil; ii) Trade refuse and domestic refuse.*
- *"No phenolic waste shall be deposited on the site without the prior consent of the Local Planning Authority".*

As described in Section 3.4 below, it appears that the bund was constructed with a sheet-piled wall on the seaward (southern / eastern) edge.

The EA has stated (**Appendix C**) that "*the site is also recorded as being a dilute and disperse facility, so any engineering is likely to be minimal*".

Historical aerial photographs available through Cambridge University's Air Photos Archive[4] (unknown date) show construction and filling of the landfill to have progressed. Pertinent details shown on these photos include:

- Harts Farm Way has been constructed on an embankment along the Site's southern boundary and a further haul/access road is present on an embankment approximately 60 m west of the edge of the

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[3] The quality of the scanned document provided by Havant Borough Council is very poor and it is not possible to read all the information.
[4] These cannot be reproduced within this report however the relevant photos are available at the links below.
https://www.cambridgeairphotos.com/data/thumbnails/640/bmv90.jpg,
https://www.cambridgeairphotos.com/data/thumbnails/640/bmv91.jpg,
https://www.cambridgeairphotos.com/data/thumbnails/640/bmv92.jpg

new channel (extending northwards from what is now a small layby on Harts Farm Way near the south-eastern corner of the Site).

- The land in the western half of the Site appears to be reworked and potentially partially infilled.
- The land in the eastern half of the Site between the haul road embankment to the east, the Harts Farm Way embankment to the south and the higher lying/reworked/filled land to the west appears to have been reworked/filled to a lesser extent. The former channel of the Hermitage Stream appears to have been partially infilled in the Site's north-eastern corner, and a possible culvert beneath Harts Farm Way is noted.
- To the south of Harts Farm Way and to the north of the bund, the former channel of the Hermitage Stream remains, and appears to contain water. A possible culvert/outfall in the bund wall at the southern end of the former channel is noted (see Section 3.4 below).

The EA has stated (**Appendix C**) that "*the site was infilled (or deposited as land raise) between around 1969 and 1987*" and "*the site is known to have taken household waste, as was as some commercial/industrial waste*". (Delta Simons, 2022) states that wastes included "*concrete waste, construction and demolition waste, household waste and incinerator residues*[5]". Further aerial photos[6] (date unknown) show the filling in the western half of the Site to have been completed and this area to be grassed/vegetated whilst filling activities in the eastern half of the Site appear to be ongoing. The land to the south of the Site appears to also have been infilled, with the former stream channel no longer visible.

On the basis of the ground investigations undertaken it appears that different types of waste have been deposited in different areas of the Site. Wastes of a more 'commercial' type appear to have been deposited in the west of the Site and wastes of a more 'domestic' type appear to have been deposited in the eastern half of the Site (more detailed descriptions provided in **Section 4** below). **Figure 2** shows the interpreted extent of these areas of waste deposition. For ease of reference these areas of waste deposition will henceforth be referred to as the western cell and the eastern cell, noting that these 'cells' are not lined and do not appear to have an engineered cap. It is unknown if there is any structure (e.g., a bund) separating the western cell from the eastern cell in the centre of the Site.

Post-Landfilling – 1990s to Present

Historical mapping dated 1987 and 1998 recorded the hard-surfaced area in the centre of the Site. The land in the west of the Site appears to be approximately level and is labelled as "Playing Field".

Planning permission 98/54097/2/HBC granted permission for "Land raising by one metre". Historical aerial imagery dated 1999 (available through Google Earth) appears to show these land-raising works being undertaken in the western half of the Site. These works were shown to be complete by the next photograph dated 2004.

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[5] A Local Authority incinerator being present approximately 200m to the east, in the location of the present-day household waste recycling centre.

[6] https://www.cambridgeairphotos.com/data/thumbnails/640/rc8ge064.jpg, https://www.cambridgeairphotos.com/data/thumbnails/640/rc8ge065.jpg

In 2005, vegetation was cleared from the western half of the Site including the trees around the boundaries. During 2007 alterations to the junction between Harts Farm Way and the A27 were carried out, and the south-western quadrant of the Site appears to have been used for stockpiling and as a construction compound.

By 2011 the Site appears to have been almost entirely restored to the pre-2005 condition, with the exception of a limited area immediately west of the access road in the centre of the parcel. Cabins and vehicles can be seen on this image and are assumed to be the works compound associated with the cover re-engineering works. By 2015 the restoration works are shown to be completed.

During 2022 trees and vegetation were cleared from around the hard-surfaced area in the centre of the Site, from a triangular area to the north of the hard-surfaced area, and in the north-eastern corner of the Site. The Site is shown in its existing configuration.

3.4 Bund and Outfall Construction

(Structural Soils Ltd., 1967) (**Appendix B**) provided recommendations for the construction of the proposed bund wall. The report provides the following statements:

- *"The shingle underlying the silt, although permeable should create a satisfactory bearing strata for any bund wall, assuming that any overlying silt is firstly removed and that the bund wall is founded at a depth into the base shingle of between [0.9 m and 1.5 m].*
- *"It is considered important that the core to the bund wall should be formed of sufficiently impermeable material to restrict the flow of sea water through the bund wall. This material could either consist of chalk or clay, provided that this fill material is compacted to its maximum dry density.*
- *"The bund wall if founded on shingle will allow water to pass under it to the area inside the wall during high tides. By constructing the core to a depth of [0.9 m to 1.2 m] below the shingle and constructing the wall in totally impermeable material the water path will be as long as is economically possible, allowing the minimum of water to flow under the wall.*
- *"Under the co-efficient of permeability values obtained [it is anticipated that] up to [0.15 m] of water inside the bund wall, and as soon as the tide drops below the inside surface level, the direction of flow will be reversed. It is anticipated that nearly all of the water passing into the inside area will percolate out at low tide, but as the mean of tides is above [Ordnance Datum] the ponding inside of the bund may on some occasions be present for a number of consecutive tides.*
- *"It is strongly recommended that an outlet pipe with a tidal flap is constructed through the bund wall in the base of the existing Storehouse Lake Channel to facilitate the immediate draining of any water in the area after each high tide".*

Following the grant of planning permission in 1968 it appears that the proposed bund was constructed. A sheet pile wall appears to have been added to the bund design, below the seaward face. Details of the length of the sheet-piles are unclear and appear to vary along different points in the bund, with various lengths of between approximately 1.8 m to 6.0 m (Drawing 639/92, **Appendix B**). The bund is indicated to be constructed of "chalk fill" (drawing 639/87, **Appendix B**). Drawing 639/112 (**Appendix B**) showing the flow-nets associated with various bund and sheet piled wall configurations indicates that when using a 2.7 m long pile, flow beneath the wall is not prevented.

Drawing 639/108 (**Appendix B**) shows details of an outfall structure within the bund wall, showing a "*Twin 36" dia. outfall in cofferdam*" was proposed, controlled by a sluice. This is potentially the structure recommended in the Structural Soils, 1967 report.

A letter from the County Surveyor to the Southern Water Authority, dated 1979 (**Appendix B**) describes the "*discharge to Langstone Harbour from Broadmarsh Refuse Tip*", stating that *"the County Council will be undertaking certain remedial works… to abate the discharge of leachate into Langstone harbour… and will involve the prevention of the major discharge of leachate through the main sluices by means of steel shuttering* *placed around the sluices and backfilling of the present anaerobic lagoon with earth spoils. Moreover, this work will be supplemented by completely covering the eastern portion of the site with earth spoils to minimise percolation of rainfall through the deposited wastes*". It is possible that the outfall structure that was sealed is the outfall / sluice in the bund at the mouth of the former Hermitage Stream channel that was recommended by Structural Soils, 1967 and potentially evident in the historical aerial photographs. DS undertook a visit to the bund in 2022 (Delta Simons, 2022) and found no evidence of a sluice/outfall at the location where it should be present.

3.4.1 Potential Groundwater Level Implications

Structural Soils' 1967 assessment of water flow into the landfill and the recommendations for an outlet to allow water to flow out of the landfill were based upon a bund toed into the gravel and did not include consideration of a sheet piled wall. The inclusion of the sheet piled wall is likely to have reduced water flow into the landfill (and leachate flow out of the landfill). However, as shown on the flow-nets on drawing 639/112 (**Appendix B**), elimination of flow beneath the sheet piled wall was not predicted to be prevented.

If the outlet structure described in the 1979 letter is indeed the outlet structure recommended by Structural Soils, and no other such outlets were constructed, following the sealing of the outlet there may be a resulting build-up of water within the landfills, with water 'pumped in' on each incoming tide faster than it is able to drain out until a pressure equilibrium is reached, i.e., the water level within the landfill may be kept artificially elevated, even at low tides.

3.5 Industrial Setting and Environmental Regulation

A Groundsure Enviro+Geo Insight report which provides information on the industrial setting of the Site was procured during the site selection process. The results of the database search, augmented with the findings of the historical mapping review, are summarised in Table 3.1 and discussed in the text that follows.

Table 3.1 Summary of Industrial Setting & Environmental Regulation

Data Type	Number on-site (1)	Number within 250 m of Site (1)
Waste Regulation		
Landfill Sites	0 (1)	0 (2)
Licensed Waste Management Facilities	0 (0)	2 (2)
Statutory Permits/Authorisations		
Pollution Prevention and Control(2)	0 (0)	0 (3)
Radioactive Substance Authorisations	0 (0)	0 (0)
Planning Hazardous Substances	0 (0)	0 (0)
COMAH(3) and NIHHS Sites(4)	0 (0)	0 (0)
Pollution Records and Contaminated Land		
Pollution Incidents (EA/NRW)	0	2
Regulated Discharge of List 1 and List 2 Dangerous Substances	0 (0)	0 (0)
Contaminated Land (5)	0	0

Data Type	Number on-site (1)	Number within 250 m of Site (1)
Potential Contaminative Uses		
Relevant Recent and Historical Industrial and Energy Land Uses	0 (0)	Multiple
Licensed Discharges to Controlled Waters	0 (0)	1 (3)
Fuel Stations and Historical Garages	0 (0)	0 (0)

Note: 1) Numbers in brackets denotes number of authorisations, licenses or permits that are lapsed, revoked, cancelled, superseded, defunct, surrendered, not applicable, inactive, withdrawn or not yet started.
2) Includes Integrated Pollution Controls, Integrated Pollution Prevention and Control, Local Authority Integrated Pollution Prevention and Control and Local Authority Pollution Prevention and Control permits.
3) COMAH denotes Control of Major Accident Hazards
4) NIHHS denotes Notification of Installations Handling Hazardous Substances
5) Sites determined as Contaminated Land under Part 2A of the Environmental Protection Act

Landfill Sites

As described above, the Site forms part of an historical landfill (Harts Farm Way, site ref: FHA15, 1760/1/13/6). This landfill also extends off-site to the south and west of the Site, within the confines of the bund wall constructed to retain the landfills in the 1960s. The landfill will be taken forwards in this assessment as a Potential Source of Contamination (PSC).

A further landfill (Land South of Budds Farm Sewage Works) is present approximately 250 m south-east (hydraulically downgradient) of the Site, separated from the Site by the Hermitage Stream and Langstone Harbour. This landfill (WRC ref: 1700/1304) is indicated to have received household waste. No information relating to operational dates or licences/permits and associated operators is provided within the EA's dataset. This landfill will not be taken forwards as a PSC on the basis of the significant distance from the Site and the presence of surface water bodies between the Site and the off-site landfill. It is considered highly unlikely that landfill gases from the off-site landfill would migrate downwards through the saturated strata beneath the stream and harbour, to emerge within the Site. It is anticipated that shallow groundwater within the superficial deposits would be in hydraulic connectivity with the adjacent surface water and therefore any leachate migrating within these deposits would be intercepted by the surface water before reaching the Site. Any contamination from the off-site landfill within the deeper chalk aquifer is unlikely to be migrating to the north-west as this would by hydraulically upgradient (noting tidal effects within the deeper aquifer are not anticipated).

Licenced Waste Management Facilities

Historically, a waste incinerator was present approximately 170 m east of the Site, in the land today occupied by a household waste recycling centre. The incinerator appears to have been constructed in the early 1980s and demolished by the late 1990s. During this time, it was operated under a waste management licence and subsequently an environmental permit (refs: EA/EPR/WP3792HZ/S002) which permitted the receipt of between 25,000 and 75,000 tonnes of household, commercial and industrial wastes.

Following the demolition of the incinerator, the land appears to have been redeveloped into the existing layout between 2011 and 2015 and used as a household waste recycling centre. The recycling centre was operated under a waste management licence and today is operated under an Environmental Permit (ref: WA/EPR/PP3198HX/S003).

A Waste Transfer Station is present on Harts Farm Way approximately 210 m east of the Site and appears to have been operational since the early 2000s, operating under waste management licences and subsequently an environmental permit (ref: EA/EPR/HB3505TQ/V002) which permits the transfer of 25,000 tonnes of wastes by UK Remediation Ltd.

A "*physical treatment facility*" appears to have been briefly operated approximately 170 m east of the Site between 2012 and 2018 by Conroys Recycling Ltd, under environmental permit ref: EA/EPR/JB3936RC/S003 which permitted the treatment of up to 25,000 tonnes of waste.

On the basis that the nearest of these waste management sites is located approximately 170 m to the east and are all separated from the Site by the Hermitage Stream (i.e., contamination migrating within the superficial deposits would be intercepted before reaching the Site), these waste management sites will not be taken forwards for assessment as a PSC.

Pollution Prevention and Control

Three Integrated Pollution Controls are recorded within 250 m of the Site, all of which relate to the former incinerator to the east of the Site. The most recent IPC was revoked in 1997 prior to the demolition of the incinerator in the late 1990s. As discussed above, the incinerator will not be taken forwards for assessment as a PSC.

Pollution Incidents

There are no Category 1 or Category 2 pollution incidents recorded within 250 m of the Site. Two Category 4 pollution incidents are recorded within 250 m of the Site as follows:

- Approximately 170 m east within the former household waste recycling centre (now Highways England depot) in February 2002. Incident ref 57618 involving release of "*other general biodegradable material or waste*". EA classified as Category 4 (No Impact) in relation to impact to water and Category 3 (Minor) in relation to impact to land.
- Approximately 170 m east within the former household waste recycling centre (now Highways England depot) in October 2003. Incident ref 195271 involving release of "*commercial waste*". EA classified as Category 4 (No Impact) in relation to both land and water.

On the basis that both incidents occurred approximately 20 years ago and are only identified as impacting land (minor) these pollution incidents will not be taken forwards for assessment as a PSC.

Licenced Discharges to Controlled Waters

A single active discharge consent is present within 250 m of the Site under environmental permit ref: EPRGB3696VZ version 1, dated October 2017. This consent is located approximately 70m east of the Site and permits the release of final/treated effluent from the adjacent aggregates wharf to the Hermitage Stream. This consent appears to replace two earlier similar consents at the aggregates wharf, one for final/treated effluent and one for site drainage, both of which were revoked in 2017 and 2013, respectively.

Multiple historical discharges are present within 250 m of the Site, typically relating to discharge of final/treated sewage effluent, treated trade effluent or run-off to the Hermitage Stream.

Based on the nature and time since surrender/revocation of the historical discharges, it is considered unlikely that the historical discharges would represent an ongoing hazard to the Site and these are therefore not taken forwards for assessment as a PSC.

The nature of the active discharge consent and the fast-flowing watercourse are such that the consent is not anticipated to present a hazard to the Site, and it is therefore not taken forwards for assessment as a PSC. It is however recognised that there may be impacts to the off-site watercourse as a result of this off-site discharge.

Relevant Recent and Historical Industrial and Energy Land Uses

The following industrial/energy land uses have been identified within 250 m of the Site:

- Historical – Sewage works located approximately 50 m north of the Site. The works is first recorded on mapping dated 1930 and comprised two filter beds and a small series of tanks. By 1939 the works had been extended with two further filter beds and further tanks. By 1972 the works had been demolished.
- Historical – Incinerator located approximately 170 m east of the Site. The incinerator appears to have been constructed in the early 1980s and comprised a yard, incinerator building and a chimney. The incinerator appears to have been demolished by the late 1990s.
- Historical – Wider landfill site north of Harts Farm Way. The land to the south and west of the Site, to the south of the A27 is part of the wider landfill, part of which is within the Site.
- Current – Bedhampton Wharf. An aggregates processing wharf located approximately 70 m south-east of the Site that comprises minerals washing plant, storage bays and an electricity substation. Appears to have been constructed on reclaimed estuary land in the 1960s following the realignment of the Hermitage Stream
- Current – Basepoint Business Centre. A collection of small commercial businesses, including offices, catering suppliers, hot tub suppliers, farm machinery sales, electrical engineers etc. Constructed between 1999 and 2004 on previously greenfield land approximately 60 m east of the Site.
- Current – National Grid 132kV substation. First recorded on mapping dated 1968 approximately 220 m east of the Site.
- Current – Yard to the north of Basepoint Business Centre, approximately 40 m east of the Site. Yard appears to be used for storage of aggregates, plant and construction materials by a public works contractor. Constructed between 2016 and 2019 on previously greenfield land.
- Current – Household Waste Recycling Centre, approximately 170 m east of the Site. Following the demolition of the incinerator, the land appears to have been used as a household waste recycling centre, being subsequently redeveloped into the existing layout between 2011 and 2015.
- Current – Waste Transfer Station. Historical aerial imagery and permitting information suggest that a parcel of land approximately 210 m east of the Site, on the western edge of the electricity substation was parcelled off from the substation and extended to the west in 1999 / 2000 and was subsequently operated as a waste transfer station.
- Current – Gas Peaking Plant. A gas-fired peaking plant was constructed on the previously greenfield land approximately 140 m east of the Site, to the north of the household waste recycling centre in 2015 / 2016.

Of the potentially contaminative land uses identified above, only the land-uses located to the west of the Hermitage Stream (historical sewage works, wider Harts Farm Way landfill) have been taken forwards for assessment as potential PSCs on the basis that contamination migrating from these land uses would likely be intercepted by the Hermitage Stream prior to reaching the Site.

3.6 Permitting Context

The EA, Havant Borough Council and Hampshire County Council have been consulted to establish the context of the site in relation to any extant Waste Management Licences (WMLs) or Environmental Permits (EPs).

The EA has stated (**Appendix C**) that "*Given that it ceased active operation in 1987, I don't think it ever licenced/permitted by the Environment Agency, and was probably regulated by Hampshire County Council. As such I don't think we would have any waste licencing/permit files*".

The information provided by HBC does not indicate that a WML was issued, or if one was it does not appear to ever have been converted to an EP.

A further enquiry was made to Hampshire County Council (HCC) in relation to historical environmental management of the site. HCC's response (**Appendix C**) states that:

> "*The EA are correct to say that the site was never licensed or permitted by themselves and any activity from the mid-1970s would have been Licenced by the County Council (under the old Control of Pollution Act I think). However, that part of the County Council, the Waste Regulation Section, actually became the Environment Agency in 1996 (along with the old National Rivers Authority and HM Inspectorate of Pollution) and they took responsibility for the regulation and licencing/permitting of waste activities, and, consequently, took all the relevant files with them.*
>
> *From a Planning perspective this site has now been completed for such a long time that there are no outstanding planning requirements. In terms of Licences, as the EA commented there was no modern Permit for the site so no modern conditions or surrender requirements, so again I do not think there will be any outstanding matters*".

On this basis, it is considered that there is not an extant EP for the Site.

4 Environmental Setting

The following section considers the site setting and context, in terms of local and regional geology, hydrogeology, hydrology and site sensitivity.

4.1 Geological Setting

3.4.1 Published Geology

The British Geological Survey (BGS) geological map of the area (BGS Sheet 316 – Fareham, Solid and Drift, 1998) and the online Geology of Britain Viewer (BGS, 2023) have been reviewed. Additionally, the Groundsure Report contains geological mapping reproduced from the British Geological Survey (BGS) mapping.

A summary of the geological maps is discussed below.

Artificial Ground

BGS mapping indicates that Made Ground present across the entirety of the Site. This is consistent with the historical review and environmental searches which indicate that the Site is located within an historical (now restored) landfill.

Superficial Deposits

The BGS indicate that the whole of the Site is underlain by Raised Marine Deposits, described by the BGS as "*Gravel (shingle), sand, silt and clay; commonly charged with organic debris (plant and shell)*". The area shown as underlain by these deposits is coincident with the area within the bund constructed in the 1960s.

The land immediately north of the Site is shown to be underlain by River Terrace Deposits, described by the BGS as "*Sand and gravel, locally with lenses of silt, clay or peat*".

The land immediately east of the Site is shown to be underlain by Alluvium, described by the BGS as "*Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel*".

To the south of the bund constructed in the 1960s the land is shown to be underlain by Tidal Flat Deposits, described by the BGS as "*commonly silt and clay with sand and gravel layers*".

Solid Geology

The entire Site area is shown to be underlain entirely by the undifferentiated chalk deposits of the White Chalk Subgroup, described by the BGS as "*chalk with flints. With discrete marl seams, nodular chalk, sponge-rich and flint seams throughout*".

4.2 Hydrogeological Setting

The superficial Alluvium, and River Terrace Deposits are classified as Secondary A Aquifers[7].

The superficial Tidal Flat Deposits and Raised Marine Deposits are classified as Secondary Undifferentiated Aquifers[8].

The Chalk bedrock is classified as a Principal Aquifer[9].

The EA's Catchment Data Explorer indicates that the groundwater beneath the Site is part of the "*East Hants Chalk Water Body*" (EA, 2023). This water body received an Overall Water Framework Directive (WFD) classification of Poor in 2019. This can be further broken down to classifications of Poor for both quantitative supply and chemical quality.

Groundwater flow within the aquifers beneath the site is anticipated to be towards the south, following the topography and leading towards the English Channel immediately south of the site. Locally to the coastline there may be daily reversals in groundwater flow direction due to tidal influences.

The Site is not located within a groundwater Source Protection Zone (SPZ) (DEFRA, 2023). The nearest such zone, an SPZ 1, is located approximately 400 m to the north.

The Site is not located within a groundwater Drinking Water Safeguard Zone. Such a zone is present approximately 400 m north of the Site, coincident with the groundwater SPZ 1.

The Groundsure Report (Groundsure Ltd., 2021) records the presence of three licenced groundwater abstractions within 1.0 km of the Site. The nearest of these is an abstraction from groundwater for potable water supply by Portsmouth Water Ltd, located approximately 500 m north of the Site.

The Site is indicated (Groundsure Ltd., 2021) to be at High vulnerability[10] to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties within a single square kilometre.

The Site is located within groundwater Nitrate Vulnerable Zone (NVZ), Ref: 2 – Chichester, Langstone and Portsmouth Harbours Eutrophic NVZ.

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[7] Secondary A aquifers are defined by the Environment Agency (EA) as "*permeable layers that can support local water supplies and may form an important source of base flow to rivers*".

[8] Secondary Undifferentiated aquifers are applied by the EA "*where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value*".

[9] Principal aquifers are defined by the EA as layers that "*provide significant quantities of drinking water, and water for business needs. They may also support rivers, lakes and wetlands*". Such strata typically have high intergranular and/or fracture permeability capable of a high level of water storage.

[10] High vulnerability is defined by the EA as "*Areas able to easily transmit pollution to groundwater. They are likely to be characterised by high leaching soils and the absence of low permeability superficial deposits*".

The Site is located within reclaimed former marine land where saline groundwater conditions are likely to be prevalent. It is therefore considered that potable abstraction is highly unlikely to be a future consideration and on this basis hydrogeology (resource) will not be taken forwards as a receptor for consideration in this assessment. This is consistent with the EA's view in an earlier consultation[11] where the EA stated, in regard to the chalk "*While it is notionally a principal aquifer, we recognise that given the site setting, it is unlikely to have significant resource potential*".

4.3 Hydrological Setting

The Hermitage Stream flows southwards immediately east of the Site towards Langstone Harbour. It is noted that this is not the original course of the stream, which was moved eastwards from its original position within the Site as part of land reclamation carried out in the 1960s.

The EA's Catchment Data Explorer (Environment Agency, 2023) indicates that the Hermitage Stream received a Water Framework Directive (WFD) classification of Moderate for Ecological Quality and Fail for chemical quality in 2019.

The Site is not located within a surface water Drinking Water Safeguard Zone (DEFRA, 2023).

The Groundsure Report (Groundsure, 2021) does not record the presence of licenced surface water abstractions within 1 km of the Site.

Several permitted discharges to controlled waters are present within 1 km of the Site. These relate principally to trade discharges and treated sewage effluent discharges (non-water company) from nearby industrial/commercial properties to either the Brockhampton Stream (a further nearby watercourse flowing into Langstone Harbour), the Hermitage Stream or Langstone Harbour, or to storm sewage overflow from Budds Farm WTW to Langstone Harbour.

Due to the presence of both Langstone Harbour approximately 200 m south of the Site, and the Hermitage Stream immediately adjacent to the east of the Site, surface water (biodiversity) will be taken forward in this assessment and will be considered a sensitive receptor.

On the basis that surface waters are not indicated to be utilised on or in the vicinity of the Site, surface water (resource) will not be taken forward as a receptor for consideration in this assessment.

4.4 Ecologically Sensitive Sites

The site is not located within 1.0 km of any National Nature Reserve (NNR) or designated area of ancient woodland.

Langstone Harbour, located approximately 200 m south of the Site is a tidal inlet of the English Channel. Langstone Harbour is a designated Site of Special Scientific Interest (SSSI), Special Area of Conservation

[11] Email from Tom Wickens (EA) to David Jackson (DS) dated 12th January 2021

(SAC), Special Protection Area (SPA), a wetland of international importance designated under the Ramsar Convention and a WFD safeguarded Groundwater Dependent Terrestrial Ecosystem (GWDTE) (DEFRA, 2023).

A local nature reserve (Southmoor Nature Reserve) is present approximately 780 m south-east of the Site. A further local nature reserve (Farlington Marshes) is located approximately 900 m west of the Site.

Due to the nearby presence of the SSSI, SAC, SPA, GWDTE and Ramsar Site ecologically sensitive sites will be taken forward and considered as a plausible receptor in this assessment.

4.5 Geological Designations

Geodiversity can be defined as "*The natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features. It includes their assemblages, structures, systems and contributions to landscapes*" (Gray, 2019). These protected sites include geological sites of SSSIs, NNRs and Regionally Important Geological and Geomorphological Sites (RIGS) also known as Local Geology Sites.

DEFRA's MAGIC (DEFRA, 2023) indicates that the Site is not located within 1.0 km of any geologically designated SSSI.

Information relating to Regionally Important Geological Sites (RIGS) in Hampshire[12] is held by the Hampshire Biodiversity Information Centre (HBIC). During a telephone conversation with HBIC it was confirmed that of the five RIGS in Hampshire, none are located within 1.0 km of the Site.

On this basis geodiversity will not be taken forward as a receptor for consideration in this assessment.

4.6 Archaeological Setting and Buildings

A preliminary appraisal of readily available sources of information has been undertaken to determine whether archaeological settings and property requires consideration within the ground condition assessment. It should be noted the statement regarding the archaeological setting does not purport to be an archaeological risk assessment which would require a separate commission.

The Historic England website (Historic England, 2023), UNESCO world heritage interactive map (UNESCO, 2023) and National Association for Areas of Outstanding Natural Beauty website (AONB, 2023) have been reviewed and pertinent features are noted below:

- A single listed structure is present within 250 m of the Site boundary. The Old Mill House is located approximately 190 m north-east of the Site.
- There are no Areas of Outstanding Natural Beauty, scheduled monuments, registered parks and gardens, world heritage sites or conservation areas located on or within 500 m the site.

[12] Havant Borough Council's Biodiversity Action Plan (2011) states that RIGS are equivalent to Sites of Importance for Nature Conservation

On the basis that a heritage receptor has been identified approximately 190 m to the north of the Site, Property (buildings) and archaeological receptors will be taken forwards in this assessment as a receptor for consideration. Old Mill House is located adjacent to the tidal Hermitage Stream, and it is considered that upgradient migration of contamination via tidal action and migration of landfill gases are the only credible pathways by which this property could be affected.

5 Tier 1 Preliminary Risk Assessment (Land Contamination)

5.1 Approach and Outline Conceptual Model

The land contamination risk assessment presented in this section is a Tier 1 Preliminary Risk Assessment (PRA). A summary of the guidance for the assessment of land contamination and the approach developed and adopted is presented in **Appendix A**.

A conceptual model identifies the types and locations of potential contamination sources, the identification of potential receptors and the identification of potential transport/migration pathways. The guidance requires a risk assessment to include the following steps:

- Identify the hazard - establish contaminant sources.
- Assess the hazard - use a source-pathway-receptor (S-P-R) pollutant linkage approach to find out if there is the potential for unacceptable risk.
- Estimate the risk - predict what degree of harm or pollution might result and how likely it is to occur.
- Evaluate the risk - decide whether a risk is unacceptable.

The findings for each step are summarised in the following subsections.

The underlying principle is the evaluation of *pollutant linkages* in order to assess whether the presence of a source of contamination could potentially lead to harmful consequences. A pollutant linkage consists of the following three elements:

- A source of contamination or hazard that has the potential to cause harm or pollution.
- A pathway for the hazard to move along / generate exposure; and
- A receptor which is affected by the hazard.

Each tier of risk assessment comprises the following four stages:

- Hazard Identification – identifying potential contaminant sources on and off site.
- Hazard Assessment – assessing the potential for unacceptable risks by identifying what pathways and receptors could be present, and what pollutant linkages could result (forming the Conceptual Site Model (CSM)).
- Risk Estimation – estimating the magnitude and probability of the possible consequences (what degree of harm might result to a defined receptor and how likely); and
- Risk Evaluation – evaluating whether the risk needs to be, and can be, managed.

A schematic CSM is presented in **Appendix D**. The sources, pathways and receptors within the CSM are described in the sections below.

5.2 Identification of Potential Sources of Contamination

The on-site and off-site Potential Sources of Contamination (PSCs) identified and associated potential contaminants of concern (PCOC) are presented in **Table 5.1**.

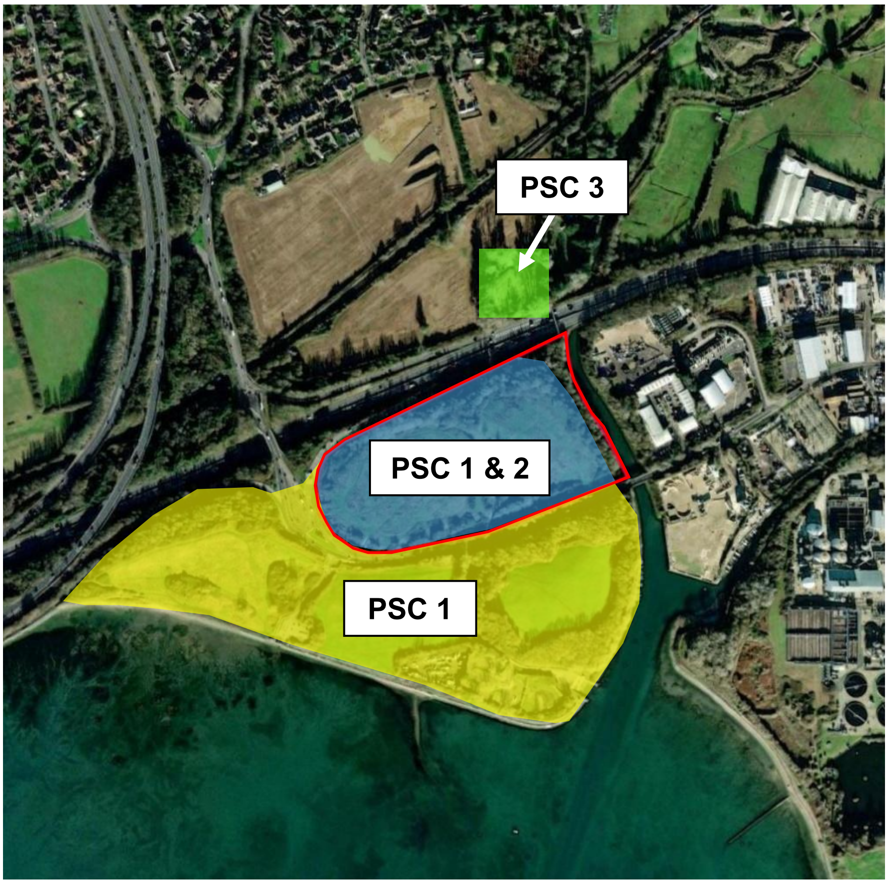
The potential contaminants identified for each land use are derived based on professional judgement and reference to published guidance. The nature of the land-use has been used to assign a hazard classification score indicating the potential contamination level.

Off-Site potential sources of contamination such as the nearby former incinerator, depots, electricity substation, household waste recycling centre, Budds Farm WWTW etc., have not been included in this assessment as the Site's historical use as a domestic, commercial and industrial waste landfill is considered likely to overwhelm any contamination migrating from the off-site sources.

Table 5.1 - Potential Sources of Contamination

PSC Reference	Description	Potential Contaminants of Concern (PCOC)
1	Landfill waste within former (now closed and restored) landfill that received domestic, commercial, and industrial wastes between 1969 and 1987 before being restored to grassland. PSC is both an on-Site and off-Site source.	Landfill leachate containing elevated concentrations of inorganic compounds including ammoniacal nitrogen. The landfill waste mass could include a variety of materials, with PCOC including asbestos, metals and metalloids, hydrocarbons (total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs), volatile and semi-volatile organic compounds (VOCs and SVOCs), poly- and per-fluoroalkyl substances (PFAS). Whilst there is potential for hydrocarbons present within the fill to migrate via the groundwater to the adjacent surface waters, there is no evidence to date that this is the case (e.g., hydrocarbon plumes have not been recorded). Landfill gases (methane, carbon dioxide, hydrogen sulphide, carbon monoxide, depleted oxygen concentrations)
2	Made Ground (restoration soils and soils imported to the western half of the Site in the late 1990s as part of land raising works to create playing fields. (On-Site source)	Asbestos, metals, and metalloids, TPH, PAHs.
3	Former sewage works located approximately 50 m north of the Site. Constructed by 1930, demolished by 1972. Comprised four filter beds and a row of tanks. (Off-Site source)	Metals, TPH, PAHs, VOCs, SVOCs, pathogens, phenols, ammonia, asbestos, cyanide, PFAS and ground gas (from infilled former tanks).

Figure 5.1 PSC Location Plan



5.3 Identification of Potential Pathways

To determine whether the identified hazards pose a risk it is necessary to identify the presence of potential receptors and pathways by which these receptors can be exposed to the hazard.

Potential hazards require a pathway connecting the source (if present) to potential receptors to impact upon the receptors. These pathways are capable of conveying the potential contaminants identified. Pathways may be anthropogenic (artificial) or natural.

Anthropogenic pathways are artificial routes capable of conveying contaminants and include such routes as surface water drains, high permeability backfill materials, poorly consolidated Made Ground, mine workings, mining induced fissures from subsidence, foundations, and persons disturbing contamination sources in such a way as to liberate contaminants.

Natural pathways are naturally occurring routes capable of conveying contaminants such as permeable strata, fractures and fissures, wind-blown material etc.

The pathways considered relevant to this assessment are described in Table 5.2.

Table 5.2 - Relevant Pathways

Receptor	Details
Human health	Ingestion of soil / dust indoors, e.g., in site cabins or in completed structures
	Ingestion of soil / dust outdoors
	Inhalation of particles (dust / soil) – outdoor
	Inhalation of particles (dust / soil) – indoor
	Vapours – outdoor – migration via natural or anthropogenic pathways
	Vapours – indoor – migration via natural or anthropogenic pathways
	Dermal absorption via direct contact with soil
Groundwater	Groundwater within permeable natural strata as a pathway allowing migration of mobile contamination leached from contaminated soils.
	Groundwater migrating via anthropogenic routes e.g., boreholes, landfill waste mass etc.
Surface Water	Runoff or discharges to surface water via existing drainage network, e.g., historical land drains, highway drainage
	Recharge of surface water in Langstone Harbour via contaminated groundwater within the shallow unconfined aquifer. The boundary, or interface, between the groundwater and surface water is in a state of dynamic equilibrium, moving with the seasonal variations of the water table and daily tidal fluctuations.
	Deposition of wind-blown dust
Buildings	Direct contact – Sulphate attack on concrete, hydrocarbon corrosion / permeation of plastic pipes
	Migration of gases / vapours through permeable natural strata, fissures or fractures etc. Migration of gases / vapours through permeable backfill materials, buried service corridors, cracks in floor slabs.
Ecologically Sensitive Sites	Runoff or discharges to surface water via existing drainage network, e.g., historical land drains, highway drainage.
	Deposition of wind-blown dust
	Recharge of surface water via contaminated groundwater

5.4 Receptor Identification

Potential receptors identified by this assessment are presented in Table 5.3. Receptors are identified at the baseline phase (i.e., the current situation, pre-construction), the construction phase of the development, and the operational phase of the development.

Table 5.3 - Potential Receptors

Receptor	Comment
Human Health – On-site	Baseline – Not Applicable. Site is vacant with no public footpaths. Construction – Ground workers constructing the Proposed Development. Operation – Workers at proposed WRP. Maintenance workers undertaking in-ground works.
Human Health – Off-site	Baseline, Construction and Operation – Workers at adjacent business park, yard, aggregates wharf etc.

Receptor	Comment
Groundwater (resource)	Baseline, Construction and Operation – Eliminated. Potable abstractions have not been identified within 250 m of the Site. The Site is located within reclaimed former marine land where saline groundwater conditions are likely to be prevalent and potable abstraction is unlikely to be viable.
Groundwater (biodiversity)	Baseline, Construction and Operation – The EA's Catchment Data Explorer indicates that the groundwater beneath the Site received an WFD classification of Poor in 2019 for chemical quality.
Surface Water (resource)	Baseline, Construction and Operation – Eliminated. Surface water abstractions have not been identified within 250 m of the Site. Both Langstone Harbour and Hermitage Stream are tidal (saline).
Surface Water (biodiversity)	Baseline, Construction and Operation - The Hermitage Stream received a WFD classification of Moderate for Ecological Quality in 2019.
Ecologically Sensitive Sites	Baseline, Construction and Operation - Langstone Harbour, is a designated SSSI, SAC, SPA, wetland of international importance designated under the Ramsar Convention and a WFD safeguarded Groundwater Dependent Terrestrial Ecosystem (GWDTE).
Geodiversity	The site is not located within 1.0 km of any geologically designated SSSI or geologically designated Local Site (RIGS).
Property – Buildings	A single listed structure (Old Mill House) is present, approximately 190 m north (i.e., hydraulically upgradient) of the Site. It is considered highly unlikely that this property would experience any impacts due to the construction of the Proposed Development, e.g., migration of contamination. A safeguarded mineral wharf is present approximately 100 m east of the Site. Assorted commercial properties and a gas peaking plant are also present within 250 m of the Site. Archaeological receptors, e.g., scheduled monuments etc., have not been identified within 500 m of the Site.

5.5 Risk Estimation

When there is a pollutant linkage (and therefore some measure of risk) it is necessary to determine whether the risk matters and therefore whether further action is required.

Risk estimation involves predicting the likely consequence (what degree of harm the receptor might suffer) and the probability that the consequences will arise (how likely the outcome is given the likely scale of contamination and the probability of exposure).

Preliminary risk estimation is based on the evaluation of publicly available data (which has been summarised and presented in this report).

Based on the current and known historical land uses, the Site has been assigned a score 4 out of 5 for the potential for generating contamination (as defined in Table 1 of **Appendix A**), as follows:

The estimated risk for each of the receptors is summarised in **Table 5.4.** This should be read in conjunction with the tables in **Appendix E** which set out the classification of risk which is a combination of consequence and probability for each potential pollutant linkage identified for the sources in **Table 5.2**. Definitions for probability and consequence are in Table 4 and Table 5 of **Appendix A** (respectively).

Table 5.4 - Summary of Estimated Risk (Preliminary Risk Assessment)

Receptor	Baseline	Construction (without Mitigation)	Completed Development (without Mitigation)
Human Health – On-Site	Not Applicable	Very High	Very High
Human Health – Off-Site	Low	High	High
Groundwater (resource)	Moderate	Moderate	Moderate
Groundwater (biodiversity)	High	High	High
Surface Water (resource)	Not Applicable	Not Applicable	Not Applicable
Surface Water (biodiversity)	Very High	Very High	Very High
Ecologically Sensitive Sites	Moderate	Moderate	Moderate
Geodiversity	Not Applicable	Not Applicable	Not Applicable
Property – Buildings and Archaeology	Low / Moderate	High	High

5.6 Risk Evaluation

The potential for the above sources of potential contamination to affect receptors (human health, surface water, ecology, buildings) has been assessed during each phase of the development (baseline, construction phase, operational phase) and a number of plausible pollutant linkages have been identified with potentially unacceptable risk associated with each. It should be noted that the risks above have been determined in the absence of any mitigation measures.

It should also be noted that the assessed risks to groundwater, surface water and terrestrial ecology are a result of the Site's use as a 'dilute and disperse' landfill which, by design, releases landfill leachate to the groundwater and the spread of contamination from the site is "working as intended". This would of course be unacceptable in the construction of a new landfill but was common and accepted practice at the time the landfill within the Site was filled.

Additional commentary is provided below relating to the potential for readily available risk mitigation measures, before the report progresses to a review of the geo-environmental conditions recorded during the ground investigation and the refinement of the Conceptual Site Model that can be undertaken as a result.

Possible pollutant linkages are determined using professional judgement. If a linkage is considered plausible with some associated risk, even if estimated to be low, it is considered that this represents a potentially 'unacceptable risk' and therefore requires further consideration.

- For risks assessed as **Low** it is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would normally be mild.
- For risks assessed as **Moderate** it is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer-term.
- For risks assessed as **High** harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short-term and are likely over the longer-term.
- For risks assessed as **Very High** there is a high probability that severe harm could arise to a designated receptor from an identified hazard. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation is likely to be required in the short term.

5.7 Risk Reduction

Risk reduction can be achieved through implementation of remediation or mitigation measures or through further tiers of assessment following collection of site-specific data. Mitigation might comprise removal of the source as well as managing the pathway.

Construction Phase

Human Health

The **High** to **Very High** assessed risks to Human Health during the construction phase are principally driven by the increased exposure to soils during construction works and the associated possibility of the dermal contact and inhalation / ingestion pathways being realised. During the construction phase, mitigation measures to limit the risk to site workers and neighbours from any potential contaminants in the ground will be implemented. Specification of appropriate measures will be the responsibility of the Principal Contractor and should be based on understanding of the site-specific assessments contained in this report and subsequent recommended assessments.

There are considered to be readily available solutions for the management of the exposure pathways including, but not limited to:

- Informing the site workers of potential contamination on the site and the potential health effects from exposure through site induction and 'tool box talks'.
- Methods of dust control and selection of appropriate methods of working to limit the potential for air-borne dust to arise associated with the excavation and disturbance of the soils present on the site.
- An emergency / contingency plan for dealing with unexpected exposure of contamination (including asbestos) during the works should be agree prior to commencement.
- Operational good practice (PPE, hygiene facilities, safe methods of work).

Surface Water, Groundwater and Ecologically Sensitive Sites

The **Moderate** to **Very High** assessed risks to surface water, groundwater and ecologically sensitive sites during the construction phase mirror those assessed at the baseline phase on the basis that the probability of the pollutant linkage being realised is already at the maximum assessed level (High) at baseline due to the Site's historical use as a dilute and disperse landfill.

It is however recognised that construction works could influence the proportion of precipitation that infiltrates into the landfill, and the rate at which the infiltration occurs, e.g., through the removal of any cover soils as part of any cut/fill works.

In addition, the potential for new sources of contamination such as leaks or spills of fuels etc., within a contractor's compound is introduced during the construction phase.

There are considered to be readily available solutions for the management of the exposure pathways including:

- Planning of works phasing to reduce and manage the amount of exposed soils at any given time.
- Appropriate measures could be included in the Construction Environmental Management Plan (CEMP) for the development, such as:
    - The use of a Soil Management Plan and a Materials Management Plan to control the on-Site use of soils. These could include requirements to locate stockpiles of contaminated soils away from watercourses, either cover stockpiles of contaminated soils or place the stockpiles within bunded areas and pump any potentially contaminated perched water from excavations for off-site treatment and disposal.
- The use of bunded fuel storage and the maintenance and use of spill kits.

Whilst the adoption of above are unlikely to provide mitigation against the long-term migration of landfill leachate from the site and the surrounding area, it will provide mitigation against the factors within the developer's control during the construction phase.

Construction Phase – Property

The **High** risk to property identified at the construction phase is principally driven by the potential for the migration of landfill gases from the Site.

Whilst the contractor's compound will likely include site cabins, these are typically temporary and are elevated above the ground surface either on blocks or 'legs', providing a ventilated void space and mitigating against the build-up of gases within the cabins. Storage containers may also be used on the Site, however these are not 'air-tight' and will usually be opened every day, preventing the build-up of gases during construction works.

It is not considered that the risks to off-site properties from migrating landfill gases will be altered during the construction phase as it is likely that the majority of gases will likely vent to the surface through the cover soils as is anticipated to be the baseline situation.

Operational Phase

Surface Water, Groundwater and Ecologically Sensitive Sites

The **Moderate** to **Very High** assessed risks to surface water, groundwater and ecologically sensitive sites during the operational phase are similar to those assessed at the baseline phase. A reduction in the probability of the relevant contaminant linkages being realised has been applied on the basis that the construction of impermeable built environment across the site (buildings, infrastructure, roads, yards etc.) and the design of the drainage to capture and treat run-off will result in a reduction in infiltration through the landfill surface and a corresponding reduction in the generation of leachate within the landfill.

Operational Phase – Property

The assessed during the operational phases is principally driven by the construction of new structures within the site, rather than an increase in the level of risk experienced by the off-site receptors (e.g., listed buildings, commercial properties etc.).

There are readily available mitigation measures such as the inclusion of gas protection measures in new enclosed structures.

6 Ground Conditions

6.1 General

The ground conditions at the Site, as revealed by the ground investigations undertaken by White Young Green (White Young Green, 2017), Delta Simons (Delta Simons, 2022) and SOCOTEC (SOCOTEC, 2023), comprise the following which are described in more detail below:

- Cover soils (restoration materials comprising inert waste).
- Domestic and commercial landfill wastes.
- Superficial deposits comprising Alluvium and River Terrace / Raised Marine Deposits.
- Chalk bedrock.

The locations of the exploratory holes undertaken as part of the ground investigations undertaken by others are presented on Figures 3a and 3b.

6.2 West 'Cell'

The exploratory holes considered to be in the west 'cell' (on the basis of the landfill waste type recorded – see below) are Delta Simons (2021) exploratory holes RO101, RO102, RO103, RO107, RO108 and TP101 to TP106, White Young Green (2017) exploratory holes CP01, CP02, CP04, CP05, TP01 to TP04, TP07 and WS01 to WS07 and SOCOTEC (2022) exploratory hole BHRP02.

A summary of the ground conditions encountered in the west 'cell' is presented in the table below:

Table 2 - Summary of Ground Conditions Encountered - West 'Cell'

Stratum	Depth to Top (m bgl)	Depth to Bottom (m bgl)	Thickness (m)	Typical Description
Cover Soils	Ground Level	1.3 to 3.5. Typically, between 2.0 and 3.0.	1.5 to 3.5	A limited thickness of TOPSOIL, overlying: Soft to firm, light grey to dark grey to brown slightly sandy to sandy variably gravelly CLAY with a low cobble content. Gravel is fine to coarse, subrounded to angular of brick, concrete, sandstone, chalk, limestone, and flint, rarely with pieces of plastic and clinker. Cobbles are brick and concrete. Occasional organic odour.
Landfill Waste	1.3 to 3.5	8.2 to 11.5 (Where full thickness proved)	4.7 to 9.0 (Where full thickness proved)	Landfill waste comprising glass, paper, wood, plastic, metal, brick, concrete, occasional fabric, rubber, ceramics, ash, and sponge and rarely carpet and steel in a matrix of very soft to soft, black slightly sandy, slightly gravelly clay or grey silty sand. Tyres recorded in TP105 and TP106. Matrix proportion varies from 95% to 10%. 'Waste' odour commonly recorded, occasional hydrocarbon odour.

Stratum	Depth to Top (m bgl)	Depth to Bottom (m bgl)	Thickness (m)	Typical Description
Alluvium	8.2 to 10.7	11.1 to 13.0 (Where full thickness proved)	0.4 to 3.5 (Where full thickness proved)	Encountered in RO101, RO107, CP02A, CP04 only. Soft to very soft brown and mottled grey, occasionally gravelly SILT. Gravel is subangular to rounded, fine to medium of chalk.
River Terrace / Raised Marine Deposits	8.9 to 11.5	11.1 to 13.0 (Where full thickness proved)	1.6 to 3.3 (Where full thickness proved)	Encountered in RO102, RO103, RO108 and CP01 only. Yellowish-brown to orangish-brown, sandy to slightly sandy and occasionally slightly clayey angular to subangular fine to medium GRAVEL of flint.
Lewes Nodular Chalk Formation	11.1 to 13.0	Proved to a maximum of 35.0 in CP01 and CPO2A	Proved to a maximum of 22.0 in CP01 andCP02A	Encountered in all exploratory holes where the full thickness of superficial deposits was proved. recovered as gravel or silt of cream to white, very weak to weak, low to medium density structureless CHALK. With occasional fine to coarse subrounded flints. Typically grades Dm to Dc, becoming C2 – B2 with depth.

Table 3 - Summary of Groundwater / Leachate Strikes and Spot Monitoring Records - West 'Cell'

Exploratory Hole	Strike During Drilling – Depth and Elevation	Stratum Within Which Strike Was Recorded	Spot Monitoring – Depth and Elevation
RO101*	11.50 m bgl -0.47 m AOD	Chalk	(Shallow response zone in waste) 7.93 to 8.25 m bgl 2.78 to 3.10 m AOD (Deep response zone in chalk) 7.57 to 8.15 m bgl 1.89 to 2.47 m AOD
RO102*	1.00 m bgl 9.04 m AOD	Cover Soils	(Shallow response zone in waste) 7.25 to 7.95 m bgl 2.50 to 3.20 m AOD (Deep response zone in chalk) 8.38 to 8.40 m bgl 2.48 to 2.50 m AOD
	9.00 m bgl 1.04 m AOD	River Terrace Deposits	
RO103*	7.60 m bgl 2.85 m AOD	Landfill Waste	(Shallow response zone in waste) 2.54 to 8.50 m bgl 1.89 to 7.85 m AOD (Deep response zone in chalk) 10.54 to 11.05 m bgl 1.63 to 2.14 m AOD

Exploratory Hole	Strike During Drilling – Depth and Elevation	Stratum Within Which Strike Was Recorded	Spot Monitoring – Depth and Elevation
RO107*	No groundwater strike	n/a	(Deep response zone in chalk) 9.57 to 9.72 m bgl 1.02 to 1.17 m AOD
RO108*	No groundwater strike	n/a	(Deep response zone in chalk) 7.43 to 7.94 m bgl 1.06 to 1.57 m AOD
TP104*	1.80 m bgl 8.19 m AOD	Cover Soils	n/a
CP01**	11.5 m bgl -0.96 m AOD	Landfill Waste / River Terrace Deposits boundary	(Shallow response zone in waste) 7.07 to 8.02 m bgl 2.52 to 2.87 m AOD (Deep response zone in chalk) 8.56 to 9.29 m bgl 1.25 to 1.98 m AOD
CP02A**	9.6 m bgl 1.19 m AOD	Alluvium	(Shallow response zone in waste) 7.98 to 8.79 m bgl 2.00 to 2.81 m AOD (Deep response zone in chalk) 9.25 to 9.54 m bgl 1.25 to 1.54 m AOD
CP04**	6.30 m bgl 5.22 m AOD	Landfill Waste	n/a
CP05**	5.90 m bgl 3.66 m AOD	Landfill Waste	(Shallow response zone in waste) 6.72 to 7.63 m bgl 1.93 to 2.84 m AOD
BHRP02***	8.5 m bgl 1.77 m AOD	Landfill Waste	(Deep response zone in chalk) 7.46 to 9.32 m bgl 0.94 to 2.81 m AOD

* = Delta Simons 2021 exploratory hole

** = White Young Green, 2017, exploratory hole

*** = SOCOTEC, 2022, exploratory hole

Groundwater levels in RO101, RO108 and BHRP02 were also monitored with a datalogger / continuous gas monitoring equipment across several tidal cycles, as summarised in the table below.

Table 6.3 - Summary of Groundwater Datalogger Levels – West ‘Cell’

Exploratory Hole	Maximum Groundwater Elevation (m AOD)	Minimum Groundwater Elevation (m AOD)	Average Tidal Range (m)
RO101 (S)	1.935	0.343	1.0
RO108	2.207	0.728	1.3

It is evident from measurements recorded in RO101 in the north-western corner of the western cell, and RO108 in the south-eastern corner of the western cell, that groundwater within the west ‘cell’ is tidally influenced across its entire area.

The water levels recorded in the boreholes screened within the waste mass may represent individual perched bodies of groundwater or landfill leachate. The water / leachate levels recorded appear to be broadly consistent, typically between 2.0 and 3.0 m bgl, suggesting that there may be a degree of interconnectedness between individual perches or that a wider groundwater / leachate table is present at this level.

Cover Soils – Comments

Given that the cover soils contain a large proportion of granular material it is considered unlikely that they are functioning as a typical landfill ‘cap’, i.e., the cover is likely to be permeable, allowing both precipitation to infiltrate into the waste mass and landfill gases to escape the waste mass.

Landfill Waste – Contact with Leachate / Groundwater

The ‘groundwater’ recorded within the cover soils is likely to be perched water within more permeable, granular layers and is unlikely to represent a laterally consistent water table.

Groundwater / leachate levels within the waste in the west cell have been recorded between m AOD 0.34 and 2.85 m AOD, the groundwater appears to be tidally influenced with a tidal range of up to 1.30 m. The elevation of the base of the waste deposit in the western cell (where the full thickness of the waste mass was proved) is between -1.94 and 3.32 m AOD. This indicates that base of the waste mass is likely to be in contact with groundwater.

Landfill Waste – Provenance

DS, 2022 state that the waste in the western cell “comprised less common household items and notably more ‘industrial’ items including large tyres, wood, metal, and large-scale deposits of metal baby-powder containers. No ‘black bag’ waste or intact newspapers etc. were encountered within the west cell”. Whilst the logs do not convey the prevalence of larger ‘industrial’ items, and photos from the west cell trial pits have not been provided, Stantec recognise that DS, having logged the wastes, will have a more nuanced assessment of the potential waste provenance than we can gain from logs and photographs alone, and in this regard, we accept their assessment.

WYG encountered a newspaper dated 1976 in the west cell. DS suggest that “the west cell was active during the 1970s and the east cell was filled until the 1980s”. Whilst the historical aerial photographs in the University of Cambridge archive are undated, they do suggest that filling and restoration of the western cell was completed whilst filling of the eastern cell was ongoing.

Landfill Waste - Extent

Whilst the depth of fill within the landfill have been investigated, the extent of the fill is unknown, i.e., no exploratory holes have been undertaken outside of the waste mass.

The historical aerial photographs and 2020 topographical survey appear to indicate that the waste mass may extend northwards up to the embankment of the A27 slip road, westwards and southwards to the Harts Farm Way embankment, and eastwards to the eastern ‘cell’.

There does not appear to be any structure separating the eastern and western cells. In reality the landfill can be considered as a single waste mass, with the western half and eastern half containing different waste types.

The vegetation along the boundaries appears to have established after filling, restoration and subsequent land-raising was completed.

6.3 East 'Cell'

The exploratory holes considered to be in the east 'cell' (on the basis of the landfill waste type recorded – see below) are SOCOTEC (2022) exploratory holes BHW001, BHW002, BHRP01, Delta Simons (2021) exploratory holes RO104, RO105, RO106, RO109, TP107 to TP120, DS101 to DS103 and White Young Green (2017) exploratory holes CP03, CP06, WS08 to WS10, TP05, TP06, TP08 and TP09

A summary the ground conditions encountered in the east 'cell' is presented in the table below:

Table 6.4 - Summary of Ground Conditions Encountered - East 'Cell'

Stratum	Depth to Top (m bgl)	Depth to Bottom (m bgl)	Thickness (m)	Typical Description
Cover Soils	Ground Level	0.9 to >4.0. Typically between 0.9 and 1.5.	0.9 to >4.0. Typically between 0.9 and 1.5.	Encountered in all exploratory holes except TP05 (WYG). A limited thickness of TOPSOIL, overlying layers of… Soft to firm brown to orangish brown slightly sandy and occasionally slightly gravelly CLAY. Gravel is subrounded to subangular, fine to coarse of "*natural lithologies*", sandstone, chalk, limestone, flint and brick, rarely with fragments of glass. Greenish brown to yellowish brown, gravelly fine to coarse SAND. Gravel is fine to coarse of brick, flint, limestone Potential Asbestos Containing Material (ACM) fragment noted in RO104 between 0.0 m and 0.39 m bgl.
Landfill Waste	0.0 to 4.0	8.2 to 16.65 (Where full thickness proved)	6.8 to 15.15 (Where full thickness proved)	Typically, paper, plastic, wood, glass, ceramics, Styrofoam, textiles, newspaper (1986), cardboard, with occasional "*organic material*", wool, metal, aluminium, concrete, leather, "*possible animal fur*" and rarely with brick and ash, carpet, rubber, cobbles of concrete. Within a matrix of very soft to soft, dark grey to black slightly sandy, slightly gravelly clay or grey silty sand. Matrix proportion varies from 10% to 90%. 'Waste' odour commonly recorded, occasional solvent and hydrocarbon odour.

Stratum	Depth to Top (m bgl)	Depth to Bottom (m bgl)	Thickness (m)	Typical Description
Alluvium / River Terrace / Raised Marine Deposits	8.2 to 10.7	10.5 to 14.0 (Where full thickness proved)	0.9 to 5.8 (Where full thickness proved)	Encountered in RO104, RO105, RO109, CP03, CP06, DS101, DS102 and DS103 only. Medium dense to dense brown to cream sandy, slightly clayey subangular to angular, fine to coarse GRAVEL of flint and occasional chalk.
Lewes Nodular Chalk Formation	10.5 to 16.6	Proved to a maximum of 65.25 in BHRP01	Proved to a maximum of 48.6 in BHRP01	Encountered in all exploratory holes where the full thickness of superficial deposits was proved. recovered as gravel or silt of cream to white, very weak to weak, low to medium density structureless CHALK. With occasional fine to coarse subrounded flints. Typically grades Dm to Dc increasing to B3 to C3 with depth.

Table 6.5 - Summary of Groundwater / Leachate Strikes and Spot Monitoring Records – East 'Cell'

Exploratory Hole	Strike During Drilling – Date, Depth and Elevation	Stratum Within Which Strike Was Recorded	Spot Monitoring – Depth and Elevation
TP09**	10/05/2017 3.9 m bgl 4.27 m AOD	Landfill Waste	n/a
RO104*	No strike recorded	n/a	(Shallow response zone in waste) 8.78 to 9.92 m bgl 1.11 to 2.25 m AOD
RO105*	09/03/2021 2.5 m bgl (fast inflow) 7.89 m AOD	Landfill Waste	(Shallow response zone in waste) 8.72 to 9.6 m bgl 0.76 to 1.73 mAOD
	09/03/2021 17.00 m bgl (fast inflow) - 6.61 m AOD	Chalk	(Deep response zone in chalk) 9.32 to 9.63 m bgl 1.25 to 1.56 m AOD
RO106*	No strike recorded	n/a	(Shallow response zone in waste) 8.72 to 9.70 m bgl 0.69 to 1.67 m AOD
RO109*	No strike recorded	n/a	8.71 to 8.84 m bgl 0.95 to 1.08 m AOD
TP112*	31/03/2021 3.50 m bgl 5.44 m AOD	Landfill Waste	n/a
TP117*	31/03/2021 2.4 m bgl (fast inflow) 7.91 m AOD	Landfill Waste	n/a
TP119*	01/04/2021 2.75 m bgl 6.63 m AOD	Landfill Waste	n/a

Exploratory Hole	Strike During Drilling – Date, Depth and Elevation	Stratum Within Which Strike Was Recorded	Spot Monitoring – Depth and Elevation
CP03**	09/05/2023 10.5 m bgl -1.83 m AOD	Landfill Waste	5.19 to 7.34 m bgl 1.33 to 3.48 m AOD
CP06**	11/05/2017 4.3 m bgl 8.1 m AOD	Landfill Waste	n/a
DS101*	No strike recorded	n/a	8.36 to 8.84 m bgl 0.58 to 1.06 m AOD
DS102*	No strike recorded	n/a	9.25 to 9.73 m bgl 1.12 to 1.60 m AOD
DS103*	No strike recorded	n/a	8.10 to 9.10 m bgl 0.82 to 1.82 m AOD
BHRP01***	08/11/2022 13.60 m bgl -0.20 m AOD	Landfill Waste	10.58 to 12.02 m bgl 1.38 to 2.82 m AOD
BHW001***	20/07/2022 7.20 m bgl 0.92 m AOD	Landfill Waste	5.75 to 6.98 m bgl 1.14 to 2.37 m AOD
BHW002***	22/07/2022 7.30 m bgl 1.13 m AOD	Landfill Waste	6.41 to 7.20 m bgl 1.23 to 2.02 m AOD

* = Delta Simons 2021 exploratory hole

** = White Young Green, 2017, exploratory hole

*** = SOCOTEC, 2022, exploratory hole

Groundwater levels in DS101, DS103, RO105 and RO109 were monitored with a datalogger or continuous gas monitoring equipment (which also recorded water levels) across several tidal cycles, as summarised in the table below.

Table 6.6 - Summary of Groundwater Datalogger Levels – East Cell

Exploratory Hole and Monitoring Period	Minimum Groundwater Elevation (m AOD)	Maximum Groundwater Elevation (m AOD)	Average Tidal Range (m)
RO105 (D) 22/03/21 to 19/04/21	2.473	1.031	1.30
RO109 22/03/21 to 19/05/21	2.129	0.528	1.50
DS101 19/04/21 to 19/05/21	1.836	0.725	0.90
DS103 19/04/21 to 19/05/21	1.009	0.657	0.10
RO104 (S) 23/03/21 to 19/05/21	2.840	2.820	N/A – Not tidally influenced
RO105 (S) 23/03/21 to 19/05/21	5.470	4.740	0.16
RO106 (S) 23/03/21 to 19/05/21	2.500	2.150	0.07

It is evident from the table above that groundwater within the east 'cell' is tidally influenced, noting however that all four monitored boreholes are located near the eastern boundary of the eastern 'cell', near the Hermitage Stream.

Cover Soils – Comments

The cover thickness in the eastern cell (typically 0.9 to 1.5 m) is less than that recorded in the western cell (typically between 2.0 and 3.0 m). It is possible that the "land raising by one metre" undertaken in the late 1990s / early 2000s may have only applied to the western cell, possibly for amenity purposes due to this area being used as playing fields, leaving the eastern cell with its original thickness of final cover. The historical aerial photograph dated 1999 shows cover soils being placed in the western cell, whereas the eastern cell does not appear to be disturbed and has well established vegetation. The subsequent photograph dated 2004 shows the eastern cell in the same configuration, suggesting that works had not taken place.

The cover soils are likely to be of variable permeability, with both cohesive and granular materials described. Unlike an engineered impermeable landfill cap, there is potential for precipitation to infiltrate through the cover soils into the waste mass and landfill gases to escape the waste mass.

Landfill Waste – Contact with Leachate / Groundwater

Groundwater / leachate levels within the waste in the east cell have been recorded between 0.657 m AOD and 3.48 m AOD, the groundwater appears to be tidally influenced with a tidal range of up to 1.50 m. The elevation of the base of the waste deposit in the eastern cell (where the full thickness of the waste mass was proved) is between -3.25 and 3.10 m AOD.

This indicates that base of the waste mass is likely to be in contact with groundwater.

Landfill Waste – Provenance

DS, 2022 states that the waste in the eastern cell "appeared to consist of more 'household waste' items including plastic containers, kitchen waste, glass bottles, newspapers, and books". Whilst the exploratory hole logs do not record all of these items, the photographs of waste arisings from the eastern cell do appear to be of a more domestic waste type. Stantec recognises that DS, having logged the wastes, will have a more nuanced assessment of the potential waste provenance than we can gain from logs and photographs alone, and in this regard we accept their assessment.

Landfill Waste - Extent

Whilst the depth of fill within the landfill has been investigated, the extent of the fill is unknown, i.e., no exploratory holes have been undertaken outside of the waste mass. The historical aerial photographs and 2020 topographical survey appear to indicate that the waste mass may extend north to the embankment of the A27 slip road, east to the bund adjacent to the Hermitage Stream and south to the Harts Farm Way embankment. The vegetation along the northern and eastern boundaries appears to have established after filling and restoration was completed.

6.4 Visual and Olfactory Evidence of Contamination

Visual evidence of contamination was limited within the cover soils to:

- Asbestos Containing Materials (ACMs) - a fragment of material suspected to be ACM was recorded in RO104 (east 'cell') in the cover soils between ground level and 0.39 m bgl.
- A "slight hydrocarbon sheen" was noted on the landfill waste recovered from RO104 between 5.00 m and 6.00 m bgl.
- Occasional black organic "staining" noted in the cover soils in RO101, RO103, RO108, RO109 and TP105.

Odours were encountered within the waste mass and cover soils, as detailed in the table below. (E) Denotes an odour in the East 'Cell' and (W) denotes an odour in the west cell.

Table 6.7 - Summary of Odours Encountered

Odour	Locations
Waste	Throughout waste mass in east and west cells.
Putrid / Foul / Rotten	(E) BHRP01, "Slight putrid" odour recorded between 1.50 and 2.65 m bgl within waste. (W) CP01, "Slight rotten" odour noted throughout waste. (E) CP06, "Rotten-type" odour noted throughout waste. (W) TP101, "Slight rotten" odour noted throughout waste. (W) TP04, "Moderate rotten" odour noted in waste from 3.00 m bgl to base of pit at 3.30 m bgl. (E) TP06, "Foul / rotten type" odour noted throughout waste. (W) TP07, "Rotten-type" odour noted in waste at base of pit at 3.30 m bgl. (E) TP108, "Slight rotten" odour noted throughout waste. (W) TP111, "Rotten" and "Foul" odours noted throughout waste. (E) TP114, "strong waste odour" recorded between 0.85 and 3.9m bgl within waste.
Solvent	(E) RO106, "Strong sweet solvent" odour recorded between 11.00 and 11.50 m bgl within waste. (E) TP108, "Moderate solvent" odour recorded between 1.40 and 4.00 m bgl within waste. (E) TP109, "Strong solvent" odour recorded between 0.90 and 3.90 m bgl within waste. (E) TP113, "Strong solvent" odour recorded between 2.00 and 3.85 m bgl within waste.
Ashy / Burnt	(E) TP05, "Ashy / burnt odour" noted between 1.40 and 3.10 m bgl in waste (ash present in waste)
Hydrocarbon	(E) BHW001, "Moderate hydrocarbon odour" recorded at 2.00 m bgl within waste. (W) RO101, "Moderate hydrocarbon odour" recorded between 3.00 and 7.00 m bgl within waste. (W) RO102, "Moderate" to "slight" hydrocarbon odour recorded between 2.20 and 3.00 m bgl within waste. (W) RO103, "Strong" to "Moderate" hydrocarbon odour recorded between 3.00 and 3.80 m bgl within waste. (W) RO103, "Moderate" to "slight" hydrocarbon odour recorded between 13.00 and 14.20 m bgl within CHALK. (E) RO104, "Moderate hydrocarbon odour" recorded between 5.00 and 7.00 m bgl within waste.

Odour	Locations
	(E) RO105, “Moderate hydrocarbon odour” recorded between 6.00 and 10.70 m bgl within waste. (E) RO106, “Slight hydrocarbon odour” recorded between 1.50 and 4.00 m bgl within waste. (W) TP102, “Slight hydrocarbon odour” recorded between 1.50 and 3.60 m bgl within waste. (E) TP112, “Slight hydrocarbon odour” recorded between 3.50 and 3.70 m bgl within waste
Organic	(E) BHRP01, “Slight organic odour” recorded between 3.20 and 4.20 m and 8.90 bgl within waste. “Moderate organic odour” recorded between 10.60 and 11.45 m bgl within waste. “Strong organic odour” recorded between 13.70 and 14.35 m bgl within waste. (E) BHW001, “Organic odour” recorded at 7.00 m bgl within waste

6.5 Design of Buried Concrete

For the mobile groundwater conditions in the brownfield soils (cover soils and landfill waste) across the site, the sulphate concentrations and pH values typically corresponded to either Design Sulphate Class DS-1 or DS2 and ACEC Class AC-1 or AC-2, respectively.

Two samples of the landfill waste (CP04 at 7.0 m bgl, in the north-west of the western cell, and BHRP01 at 13.80 m bgl in the north of the eastern cell) recorded values that correspond to Design Sulphate Class DS-4 and ACEC Class AC-4.

One sample of the cover soils (BHRP02 at 0.3 m bgl in the north-east of the western cell) recorded values that correspond to Design Sulphate Class DS-5 and ACEC Class AC-4s.

Overall, it is recommended that a Design Sulphate Class DS-2 and ACEC class AC-2 is likely to be appropriate for the majority of the buried concrete.

The recommendations of BRE (2017) should be followed in the design of mixes for buried concrete for the classifications given.

7 Geo-Environmental Conditions

7.1 Approach

In accordance with the guidance given in LCRM the results of the geoenvironmental laboratory testing undertaken on the samples of soil and groundwater recovered during the Delta Simons and WYG ground investigations (Delta Simons, 2021) (White Young Green, 2017) have been compared to current published generic assessment criteria (GAC) to identify potential hazards to the plausible receptors.

LCRM refers to this as a Tier 2 or Generic Quantitative Risk Assessment).

If the result of an analysis is below the screening criterion (selected GAC), the parameter is deemed not to be a potential hazard and is not considered further. A concentration above the screening criterion identifies the parameter is considered as a possible hazard and indicates that either further assessment or risk management is required.

Our guide entitled Rationale for Selection of Criteria Used in Tier 2 (Generic) Risk Assessment (England) is presented in **Appendix F** and further information relating to the specific GAC selected for this assessment and the justification for their selection is provided in **Appendix G.**

7.2 Cover Soils

Thirty-eight samples of the cover soils were submitted for laboratory analysis, the results of these analyses are tabulated in **Appendix H.1**.

GQRA - Protection of Human Health

The notable results are summarised below:

- None of the 38 samples recorded concentrations of metals, petroleum hydrocarbons, BTEX[13], VOCs, or SVOCs greater than the adopted GAC.
- Benzo(a)pyrene – one of the 38 samples (TP09 at 0.40 m bgl) recorded a concentration of 36.63 mg/kg, greater than the 35 mg/kg GAC.
- Dibenzo(a,h)anthracene – One of the 38 samples (TP09 at 0.40 m bgl) recorded a concentration of 4.72 mg/kg, greater than the 3.5 mg/kg GAC.

  TP09 is located in the centre of the site, beneath the former ‘yard’. The log for this trial pit records a layer of asphalt and sub-base to 0.35 m bgl. On the basis that TP09 was the only location to record asphalt, and the only location to record elevated PAHs at a shallow depth, it is considered possible that fragments of asphalt may have been included in the sample, resulting in the elevated PAH concentrations.
- Asbestos – 33 samples were analysed and two (TP03 at 0.4 m bgl and CP04 at 0.5 m bgl) returned positive detections. Both exploratory holes were located in approximately the centre-north of the west ‘cell’. The asbestos was recorded as insulation board and fibre bundles, and as both chrysotile and

[13] Benzene, Toluene, Ethylbenzene, Xylenes

amosite. Quantification of the insulation board from TP09 at 0.40 m bgl was not possible. The sample from CP04 at 0.5 m bgl returned a quantification result of <0.1%.

- A "potential ACM fragment" was encountered in the cover soils in RO104 in the north of the east 'cell' between ground level and 0.39 m bgl. Laboratory analysis does not appear to have been undertaken to confirm whether this material was ACM.

7.3 Waste Mass

GQRA – Protection of Human Health

Laboratory analyses were undertaken on 61 samples of the waste mass (noting that not all samples had the same suite of testing), the results of these analyses are tabulated in **Appendix H.2**. The results are summarised below:

- Concentrations of metals, petroleum hydrocarbons, BTEX, VOCs, and SVOCs were below the adopted GAC in all samples.
- Concentrations of PAHs were below the adopted GAC in all samples with the exception of BHW001 at 2.1 m bgl which recorded concentrations of dibenzo(a,h)anthracene in excess of the GAC[14].

  Whilst not in excess of a GAC, it is noted that the samples recovered from TP01 at 1.9 m bgl and TP04 at 3.3 m bgl recorded elevated TPH concentrations of 11,589 mg/kg and 9,850 mg/kg respectively.
- Asbestos (Screening & quantification) – 14 of 50 samples tested recorded the presence of asbestos. Asbestos was most commonly recorded as fibre bundles, loose fibres, insulation board, cement debris and insulation debris were also encountered in one sample each. Where quantification was undertaken, the maximum result was <0.1%.

7.4 Natural Soils

GQRA - Protection of Human Health

Laboratory analyses were undertaken on one sample of the Raised Marine Deposits, two samples of the Alluvium and six samples of the Lewes Nodular Chalk Formation (noting that not all samples had the same suite of testing), the results of these analyses are tabulated in **Appendix H.3**.

- None of the nine samples recorded concentrations of metals, petroleum hydrocarbons, PAHs, BTEX, VOCs or SVOCs greater than the adopted GAC, and asbestos was not detected in any of the 5 samples analysed.

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[14] The sample recovered from BHW001 at 2.1 m recorded a dibenzo(a,h)anthracene concentration of 8.53 mg/kg, equal to this sample's method detection limit which is well in excess of the limit for other similar samples. A review of the laboratory's report for this sample indicates that "*a non-standard volume or mass has been used for this test which has resulted in a raised detection limit*". On this basis, it is considered that the 8.53 mg/kg concentration recorded in this sample is a 'true' detection, and this sample should be disregarded.

7.5 Groundwater / Landfill Leachate

GQRA - Protection of Controlled Waters

Laboratory analyses were undertaken on 26 samples of groundwater and landfill leachate recovered during four rounds of sampling from boreholes with installation response zones within the waste mass, and 55 samples of water recovered from boreholes with installation response zones within the natural strata beneath the landfill. The results of these analyses are tabulated in **Appendix I.1**.

It is noted that many boreholes have multiple monitoring installations at different depths, and in different strata, in the same borehole, therefore the same borehole number may appear in both of the tables. Summaries of the results are presented below:

Table 7.1 – Summary of Groundwater / Landfill Leachate Results – EQS Exceedances, Samples Recovered from Response Zones in Waste Mass

Determinand	EQS (µg/l)	Number of Tests	Number of Exceedances	Maximum Result (µg/l)
Copper	3.76	26	19	37.0 (RO101)
Nickel	8.6	26	16	52.0 (RO102)
Zinc	6.8	26	14	38.0 (RO103)
Ammoniacal Nitrogen as NH_3 (Ammonia)	21	25	25	250,000 (RO102)
Benzene	8	26	2	10.5 (RO101)
Naphthalene	2	26	7	10.20 (RO101)
Anthracene	0.1	26	4	0.69 (RO106)
Fluoranthene	0.0063	26	4	1.30 (RO106)
Benzo(b)fluoranthene	0.017	26	1	0.28 (RO106)
Benzo(a)pyrene	0.00017	26	1	0.47 (RO106)

Table 7.2 – Summary of Groundwater Results – EQS Exceedances, Samples Recovered from Response Zones in Superficial Deposits (Raised Marine / River Terrace Deposits and Alluvium)

Determinand	EQS (µg/l)	Number of Tests	Number of Exceedances	Maximum Result (µg/l)
Copper	3.76	13	9	30.0 (DS102)
Nickel	8.6	13	12	130 (DS102)
Zinc	6.8	13	3	13.0 (DS103)
Ammoniacal Nitrogen as NH_3 (Ammonia)	21	12	12	190,000 (DS102)
Naphthalene	2	13	2	14.8 (DS101)
Anthracene	0.1	13	2	0.45 (DS101)
Fluoranthene	0.0063	13	3	0.71 (DS101)
Mercury	0.07	13	1	0.19 (DS103

DS101, DS102 and DS103 (the wells with the highest exceedances) are screened in the River Terrace / Raised Marine Deposits, with response zones only 0.5 m below the base of the waste mass. It appears likely from the Table 7.2 and **Appendix I.2** that the water in these strata, at such a s/hallow depth below the base of the waste, may be impacted by the waste mass.

Table 7.3 and **Appendix I.3** summarise the concentrations recorded with groundwater recovered from response zones installed within the chalk at depth below the waste.

Table 7.3 - Summary of Groundwater Results - EQS Exceedances for Response Zones in Chalk

Determinand	EQS (µg/l)	Number of Tests	Number of Exceedances	Maximum Result (µg/l)
Copper	3.76	42	28	17.0 (RO101)
Nickel	8.6	42	30	60.0 (RO101)
Zinc	6.8	42	18	540 (RO106)
Lead	1.3	42	3	19.0 (RO104)
Iron	1000	4	1	3,450 (BHRP02)
Ammoniacal Nitrogen as NH_3 (Ammonia)	21	38	37	140,000 (RO101)
Naphthalene	2	42	1	2.02 (RO106)
Fluoranthene	0.0063	42	1	0.29 (RO106)

Volatile and Semi-Volatile Organic Compounds

Concentrations of VOCs and SVOCs in excess of the laboratory limit of detection, but for which there are no defined GAC are presented in Table 7.4.

Table 7.4- Summary of VOC / SVOC Positive Detections

Determinand	Number of Positive Detections	Stratum within which Positive Detections were Recorded	Maximum Concentration (µg/l)
1,2-Dichlorobenzene	2 (RO101 x 2)	1 x landfill waste 1 x Chalk	8.7 (RO101)
1,4-Dichlorobenzene	3 (RO101 x 2 and DS102)	1 x landfill waste 1 x Raised Marine Deposits 1 x Chalk	2.5 (RO101)
1,2,4-Trimethylbenzene	2 (RO101 and RO103)	2 x landfill waste	15.0 (RO103)
1,3,5-Trimethylbenzene	2 (RO101 and RO103)	2 x landfill waste	7.2 (RO103)
2,4-Dimethylphenol	3 (RO101 x 2 and RO103	2 x landfill waste 1 x Chalk	5.2 (RO101)

On the basis of the above, groundwater in both the shallow superficial deposits and the chalk bedrock aquifers appears to be impacted by the landfill, albeit to differing degrees.

- Concentrations of copper and nickel from the groundwater in the chalk are approximately half of the concentrations recorded in the groundwater from the superficial deposits.
- Concentrations of zinc are similar in both the superficial and chalk aquifers, noting that three (out of 76 samples) significant exceedances were recorded in the chalk at depth.
- Ammonia concentrations are significantly elevated in both the chalk and the superficial deposits, albeit concentrations in the chalk appear to be approximately 25% lower than in the superficial deposits.
- PAH concentrations are not significantly elevated in either the chalk or the superficial deposits. Elevated concentrations in the chalk were recorded in one sample only, and the concentrations recorded in this sample were only marginally elevated above the GAC.

- Overall, there does not appear to be a spatial bias to where NAPL may be present, and it may be present within both the east cell and the west cell.
- Concentrations of chloride (normally an indicator of landfill contamination) have not been treated as diagnostic due to the likely presence of saline groundwater, i.e., water that is naturally elevated in sodium chloride.

7.6 Surface Water

GQRA - Protection of Controlled Waters

Laboratory analyses were undertaken on 12 samples of water recovered from the Hermitage Stream during two separate monitoring rounds. Four samples were recovered from a sampling point upgradient of the Site, four samples at a sampling point downgradient of the Site and four samples at a sampling point between the upgradient and downgradient sampling points.

The sampling locations were not provided within the Delta Simons reports, however a marked up aerial image was subsequently provided by Delta Simons to show the locations, and is presented as Figure 7.1 below.

Figure 7.1 – Delta Simons Surface Water Sample Locations

The results of these analyses are tabulated in **Appendix I.4**. The results are summarised below.

Upstream Sampling Point – GAC Exceedances

Table 7.5 - Summary of Surface Water Results – GAC Exceedances, Upstream Sampling Point

Determinand	GAC (µg/l)	Number of Tests	Number of Exceedances	Maximum Result (µg/l)
Copper	3.76	4	4	6.8
Ammoniacal Nitrogen as NH_3 (Ammonia)	21	4	2	48.0

All four samples recorded elevated concentrations of copper. The concentrations recorded are noted to be similar on the high and low tide. This indicates that copper concentrations in the Hermitage Stream may be elevated prior to reaching the Site and that either an off-site source of copper may be present, or concentrations of copper may be naturally elevated.

The elevated ammonia concentrations were both recorded in the high-tide samples, with both low tide samples recording concentrations below the laboratory LOD of 15 µg/l. This suggests that elevated ammonia concentrations upgradient of the site may be a result of ammonia-rich waters (potentially a result of leaks of leachate from the landfill into the downgradient water, or from ammonia rich waters within Langstone Harbour) being washed up the Hermitage Stream on the rising tide. Once the tide has receded the concentrations of ammonia then fall within the Stream as the upgradient water would be principally comprised of flows from further upgradient of the Site.

Concentrations of hydrocarbons (both TPHs and PAHs) were below the laboratory LOD in all samples.

Midstream Sampling Point – GAC Exceedances

Table 7.6 - Summary of Surface Water Results – GAC Exceedances, Midstream Sampling Point

Determinand	GAC (µg/l)	Number of Tests	Number of Exceedances	Maximum Result (µg/l)
Copper	3.76	4	2	11.0
Zinc	6.8	4	1	31.0
Ammoniacal Nitrogen as NH_3 (Ammonia)	21	4	3	130.0

The elevated concentrations of copper were recorded in samples recovered at both low and high tide with concentrations of 5.1 µg/l (low tide) and 11.0 µg/l (high tide) recorded.
The elevated concentration of zinc was recorded at low tide.

The exceedances of ammonia were recorded in samples recovered at both high tide (31.0 µg/l) and low tide (100 µg/l and 130 µg/l). Elevated concentrations at low tide adjacent to the Site, but not upgradient of the Site, may indicate a source of ammonia being released into the Stream, close to the Site.

It is considered likely that leachate from within the landfill is being released to the Hermitage Stream. It should be noted that this is the expected behaviour for an un-lined “dilute and disperse” landfill.

Concentrations of TPHs and PAHs were below the laboratory LOD in all samples.

Downstream Sampling Point – GAC Exceedances

Table 7.7 - Summary of Surface Water Results – GAC Exceedances, Downstream Sampling Point

Determinand	GAC (µg/l)	Number of Tests	Number of Exceedances	Maximum Result (µg/l)
Copper	3.76	4	4	9.4
Ammoniacal Nitrogen as NH_3 (Ammonia)	21	4	2	92

Elevated concentrations of copper downgradient of the Site were recorded at both high and low tide with concentrations between 5.0 µg/l and 9.4 µg/l recorded.

Elevated concentrations of ammonia were recorded downgradient of the Site at low tide only, with concentrations between 87 µg/l and 92 µg/l recorded. This suggests that either a) there is a source of ammonia downgradient of the Site or b) water flowing downgradient from the Site is enriched in ammonia.

It is considered that both options are likely to be happening, noting that the land to the south of the site, within the bund, has also been used for landfilling and is also of the same “dilute and disperse” type.

Concentrations of TPHs and PAHs were below the laboratory LOD in all samples.

8 Landfill Gas Risk Assessment

8.1 Review of Spot Monitoring Information

Spot Monitoring - Monitoring Rounds Undertaken

As part of their 2017 ground investigation, WYG undertook six rounds of spot monitoring on boreholes CP01 (S) and (D), CP02 (S) and (D), CP03 (S) and (D), CP04 to CP06 and WS01 to WS10. Following completion of their 2021 ground investigation Delta Simons (DS) undertook ground gas 'spot monitoring'. Monitoring was undertaken both on DS's newly installed boreholes and WYG's earlier boreholes.

Whilst DS reported that six rounds of monitoring were undertaken, two of the rounds appeared to be repeat rounds undertaken on certain boreholes by the provider of the continuous monitoring equipment (Ground Gas Solutions [GGS]) on the same day that DS undertook their monitoring.

Table 8.1shows which boreholes were monitored during which monitoring rounds.

Table 8.1 - Summary of Delta Simons Gas Spot Monitoring

Borehole	Monitoring Round					
	22-23 March 2022 (DS)	23 March 2021 (GGS)	20 April 2021 (DS)	20 April 2021 (GGS)	4 May 2021 (DS)	18-20 May 2021 (DS)
RO101 (S)	✓	✓	✓	✓		✓
RO102 (S)	✓	✓	✓	✓		✓
RO103 (S)	✓	✓	✓	✓		✓
RO104 (S)	✓	✓	✓	✓		✓
RO105 (S)	✓	✓	✓	✓		✓
RO106 (S)	✓	✓	✓	✓		✓
RO107 (D)	✓		✓		✓	✓
RO108 (D)	✓		✓		✓	✓
RO109 (D)	✓		✓		✓	✓
DS101	✓		✓		✓	✓
DS102	✓		✓		✓	✓
DS103	✓		✓		✓	✓
CP02A (S)	✓		✓		✓	✓
CP02A (D)	✓		✓		✓	✓
CP03 (S)	✓		✓		✓	✓
CP03 (D)	✓		✓		✓	✓
CP05 (S)	✓		✓		✓	✓

DS reported that the atmospheric pressure trends during five of their six monitoring rounds were of falling pressure (the visit on 18/05/2021 being falling, then rising pressure). Falling atmospheric pressure is associated with gas migration potential as it causes gas to expand and come out of the ground. However, this is only likely to occur where there are open pathways in the ground and not for soils with low permeability (Card, 2019)

Spot Monitoring - Review of Water Levels

A review of the water levels in the boreholes indicates that:

- During the WYG monitoring, the water level in boreholes CP01(D), CP02A(D) and CP03A(D) was above the top of the response zone.
- During the Delta Simons monitoring, the water level in boreholes CP02A(D), CP03A(D), DS101, DS102, DS103, RO107(D), RO108(D) and RO109(D) was above the top of the response zone.

The data from these boreholes has therefore been disregarded from this ground gas risk assessment as "*The response zone of the gas monitoring standpipe should be wholly or partly above groundwater level to provide valid data...* [and] *gas standpipes with flooded response zones might exhibit measurements of elevated methane or carbon dioxide… due to dissolved gases or the presence of biodegradable material in the groundwater*" (BS8485: 2015 + A1: 2019).

It is noted that all boreholes which recorded completely flooded response zones were screened within the chalk underlying the waste mass. Therefore, the absence of this data from the assessment is not considered to impact the assessment.

Spot Monitoring – Concentrations and Flow Rates

The steady-state concentrations of ground gases and ground gas flow rates measured over six monitoring occasions (May-June 2021) in the gas monitoring wells installed in the boreholes are summarised in the following table.

For the purposes of the assessment below, a gas concentration or flow rate of less than the limit of detection (LOD) of the monitoring instrument is treated as 100 per cent of the LOD (i.e., 0.1 %v/v or 0.1 l/hr).

Table 8.2 - Summary of Delta Simons & WYG Spot Monitoring (May-June 2021)

Exploratory Hole	Flow (l/hr)	Carbon Dioxide (%v/v)	Methane (%v/v)
CP01 (S)	0.3 to 0.6	28.2 to 30.1	67.5 to 70.6
CP02A (S)	0.1 to 0.4	0.2 to 24.6	0.1 to 35.9
CP03 (S)	0.1 to 0.6	14.2 to 27.4	15.1 to 48.1
CP04	0.3 to 0.5	30.1 to 31.2	61.0 to 63.9
CP05 (S)	0.1 to 0.5	16.6 to 28.0	22.0 to 52.1
CP06	0.1 to 0.6	21.5 to 23.2	55.0 to 60.1
RO101 (S)	0.1 to 3.1	20.4 to 25.5	37.1 to 65.0
RO102 (S)	0.1 to 0.4	15.5 to 25.1	57.6 to 62.8
RO103 (S)	0.1 to 0.7	21.3 to 28.0	58.4 to 67.4
RO104 (S)	0.1	9.4 to 22.2	14.3 to 36.0
RO105 (S)	0.1 to 0.2	0.7 to 13.2	0.1 to 19.3
RO106 (S)	0.1 to 3.5	14.4 to 24.6	28.5 to 53.7

Spot Monitoring – Calculation of Gas Screening Values

Initial Calculation Stage

Using the procedure for classifying gassing sites proposed by BS 8485:2015 + A1:2019, Gas Screening Values (GSVs) have been calculated for both carbon dioxide and methane for each monitoring visit to each borehole.

Table 8.3 - Calculated GSVs (Per Borehole, Per Visit)

Exploratory Hole	Carbon Dioxide GSV	Methane GSV	Corresponding Characteristic Situation
CP01 (S)	0.0849 to 0.1746	0.2118 to 0.4086	CS2
CP02A (S)	0.0006 to 0.0492	0.0001 to 0.0718	CS1 to CS2
CP03 (S)	0.0142 to 0.1170	0.0151 to 0.1428	CS1 to CS2
CP04	0.0903 to 0.1545	0.1881 to 0.3195	CS2
CP05 (S)	0.0166 to 0.1310	0.0220 to 0.2200	CS1 to CS2
CP06	0.0223 to 0.1392	0.0561 to 0.3480	CS1 to CS2
RO101 (S)	0.0204 to 0.7378	0.0371 to 1.5469	CS1 to CS3
RO102 (S)	0.0155 to 0.0940	0.0576 to 0.2368	CS1 to CS2
RO103 (S)	0.0213 to 0.1960	0.0584 to 0.4718	CS1 to CS2
RO104 (S)	0.0094 to 0.0222	0.0143 to 0.0360	CS1
RO105 (S)	0.0007 to 0.0132	0.0001 to 0.0202	CS1
RO106 (S)	0.0144 to 0.8610	0.0285 to 1.8795	CS1 to CS3
Notes: As per Table 2 of BS 8485:2015 + A1:2019 CS1 = <0.07 CS2 = 0.07 to 0.7 CS3 = 0.7 to 3.5 CS4 = 3.5 to 15.0			

Table 2 of BS 8485 notes, in the additional factors for a CS1 classification that this requires "*typically <1% methane concentration and <5% carbon dioxide concentration, otherwise consider an increase to CS2*". Methane and carbon dioxide concentrations have been recorded consistently above these threshold concentrations across all monitoring visits, and therefore the increase from CS1 to CS2 is considered appropriate.

On this basis, the calculated GSVs correspond to a low to moderate hazard potential.

Additional Checks

As advocated by BS8485, further assessment has been undertaken using the highest flow rates and gas concentrations recorded within each borehole across all visits.

Table 8.4 - Calculated GSVs (Per Borehole, Across All Visits)

Exploratory Hole	Carbon Dioxide GSV	Methane GSV	Corresponding Characteristic Situation
CP01 (S)	0.1806	0.4236	CS2
CP02A (S)	0.0984	0.1436	CS2
CP03 (S)	0.1644	0.2886	CS2
CP04	0.1560	0.3195	CS2
CP05 (S)	0.1400	0.2605	CS2
CP06	0.1392	0.3606	CS2
RO101 (S)	0.7905	2.0150	CS3
RO102 (S)	0.1004	0.2512	CS2
RO103 (S)	0.1960	0.4718	CS2
RO104 (S)	0.0222	0.0360	CS2*
RO105 (S)	0.0264	0.0386	CS2*
RO106 (S)	0.8610	1.8795	CS3
* Denotes an increase from CS1 to CS2 on the basis of recorded concentrations as per Table 2 of BS 8485			

As shown in the table above, the majority of boreholes recorded per-borehole worst-case GSVs equivalent to a characteristic situation of CS2, with only two boreholes (RO101 (S) and RO106 (S)) recording worst-case GSVs equivalent to a characteristic situation of CS3.

On the basis of the spot monitoring, it is considered appropriate to adopt the worst-case classification of CS3 across the whole of the site. Whilst RO101 and RO106 are both located in the eastern 'cell', there is no barrier to gases from the eastern cell migrating westwards to the immediately adjacent western 'cell' and therefore it is not considered appropriate to zone the site.

Worst Case Check

Finally, as also advocated by BS8485, a 'worst-case' check has been undertaken using the highest flow rates and gas concentrations recorded across all monitoring visits combined and in any borehole across all monitoring visits combined.

Using the maximum flow rate of 3.5 l/hr, the maximum carbon dioxide concentration of 31.2 %v/v and the maximum methane concentration of 70.6 %v/v GSVs of 1.092 and 2.471 are calculated, both equivalent to CS3.

On the basis that CS3 conditions have been recorded in two boreholes during the spot monitoring, it is considered that the worst-case classification of CS3 is appropriate and suitably precautionary.

This classification means that gas protection measures will be required.

8.2 Review of Continuous Monitoring Information

As part of their 2021 investigation, Delta Simons installed continuous gas monitoring systems on boreholes RO101 to RO106 as shown in the table below.

The monitoring equipment were configured to record at an hourly monitoring frequency, with instruments recording atmospheric pressure, temperature and gas concentrations; methane (CH4), carbon dioxide (CO2), oxygen (O2), carbon monoxide (CO) and hydrogen sulphide (H2S). Continuous gas flow was also recorded.

Table 8.5 - Continuous Gas Monitoring Time Periods

Borehole	Time Period
RO101 (S)	20/04/21 to 19/05/21 (4 weeks)
RO102 (S)	20/04/21 to 19/05/21 (4 weeks)
RO103 (S)	20/04/21 to 19/05/21 (4 weeks)
RO104 (S)	23/03/21 to 19/05/21 (8 weeks)
RO105 (S)	23/03/21 to 19/05/21 (8 weeks)
RO106 (S)	23/03/21 to 19/05/21 (8 weeks)

Continuous Monitoring – Purge and Recovery Tests

Purge and Recovery Tests (PRTs) were undertaken in RO101 (S), RO103 (S), RO104 (S) and RO106 (S). The PRT allows the recovery rate of ground-gas into a monitoring well to be recorded following displacement of gases within the monitoring well with nitrogen gas, from which a ground-gas flux is calculated.

A ground-gas flux is an indication of the rate of gas entering the purged well void; typically, a slow recovery indicates low generation or the presence of a low pressure 'reservoir'. Rapid recovery can either indicate high generation or the presence of a pressurised 'reservoir' of ground-gas held within the pore spacing and voids of the vadose zone which immediately refills the borehole space after purging.

The permeability of the surrounding geology also effects recovery rates; a highly permeable media such as gravel and sand surrounding the borehole will allow faster gas recovery than a less permeable media such as silt and clay.

The calculated gas flux rates for methane and carbon dioxide, and the equivalent characteristic situations, are presented in Table 8.6 below.

Table 8.6 - Carbon Dioxide and Methane Flux Comparison

Borehole	Methane Flux (l/hr)	Characteristic Situation - Methane	Carbon Dioxide Flux (l/hr)	Characteristic Situation – Carbon Dioxide
RO101 (S)	7.06	CS4	4.04	CS4
RO103 (S)	8.05	CS4	3.85	CS4
RO104 (S)	0.03	CS1	0.03	CS1
RO106 (S)	3.41	CS2 / CS3	1.80	CS2

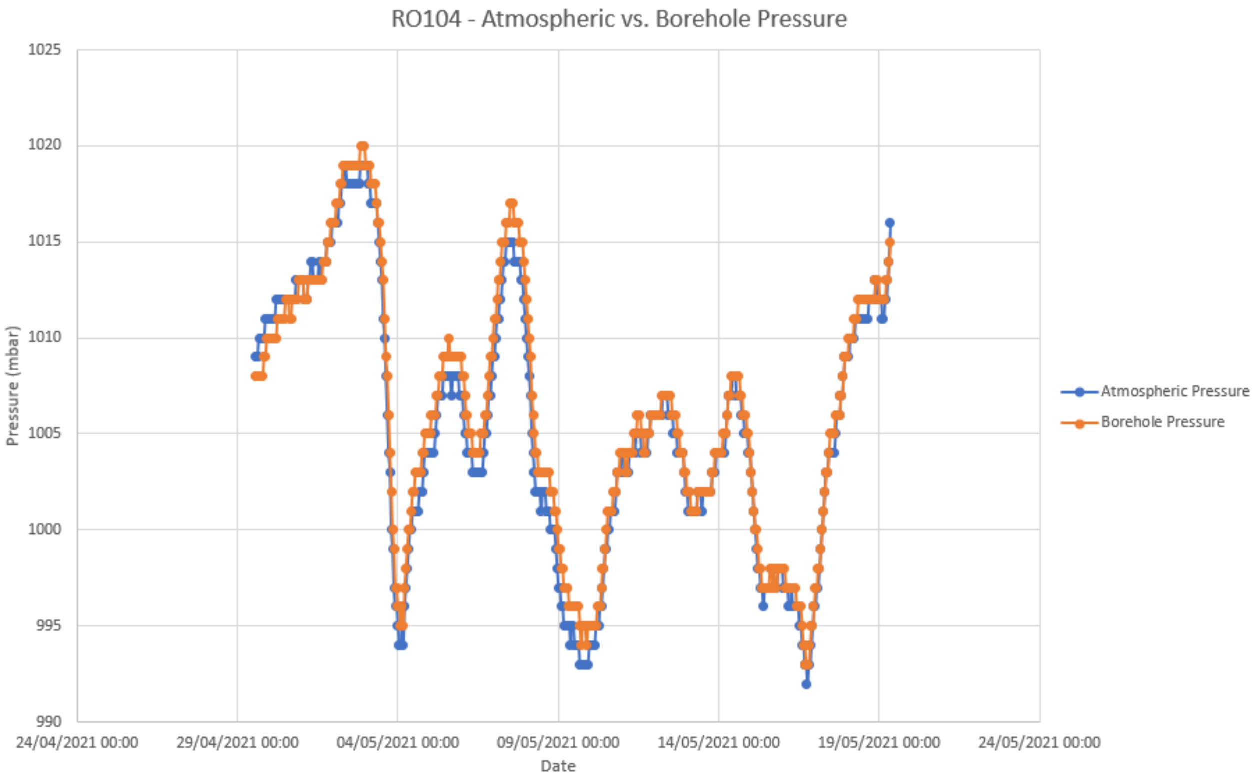
Continuous Monitoring – Borehole Pressure vs. Atmospheric Pressure

The pressure within a borehole is not always equal to the atmospheric pressure outside of the borehole. In absence of outside factors (e.g., groundwater level change, barometric pumping etc.), within a borehole that is adequately sealed at the surface, and with a closed gas valve, borehole pressure will typically lag behind atmospheric pressure.

In general, when the atmospheric pressure is higher than the borehole pressure, gas flow from the borehole will be supressed. When borehole pressure is higher than atmospheric pressure, gas flow from the borehole will be increased.

Atmospheric pressure and borehole pressure readings were taken at one-hour intervals as part of the continuous monitoring, with the exception of borehole RO102 where borehole pressure was not recorded. When the two datasets are compared it is evident that there is very little difference between the two, as shown in the example graph below from borehole RO104.

Figure 8.1 - RO104 - Graph of Atmospheric Pressure vs. Borehole Pressure



This suggests that either:

a) The borehole is not sealed and that atmospheric pressure external to the borehole is able to equilibrate with the pressure within the borehole.
b) The ground surrounding the boreholes is very highly permeable, such that pressure changes are rapidly conveyed through the subsurface into the borehole.

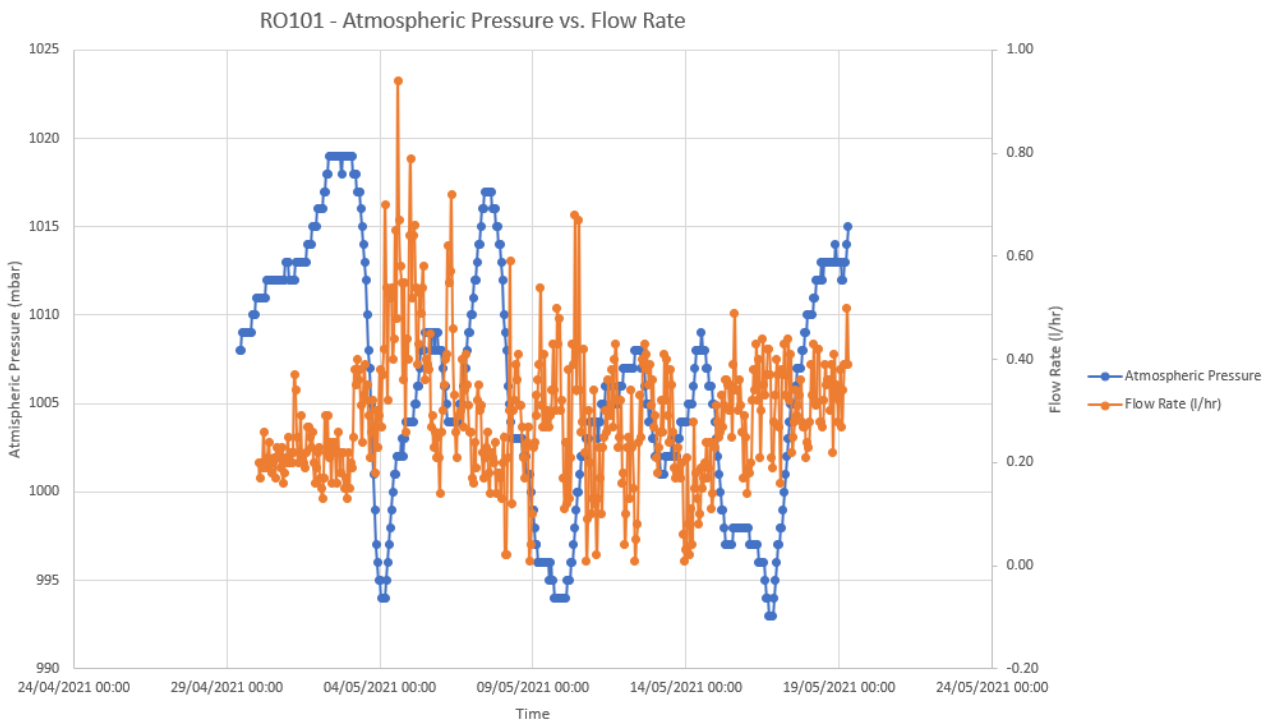
It is considered that option a) is the most likely – however this does not affect the integrity of this assessment as gas flows will reflect atmospheric pressure changes.

Continuous Monitoring – Flow Rate and Flow Drivers

For each of the continuously monitored boreholes the gas flow rate has been compared individually against the groundwater level and the atmospheric pressure (noted above to be practically indistinguishable from the borehole pressure). This comparison allows for an assessment to be made of the influences on gas flow.

Within boreholes RO101 (S) to RO104 (S) and RO105 (S) it appears that there is a slight correlation between falling atmospheric pressure and increased gas flow rate. The example graph from RO101 (S) (Figure 5) shows that spikes in gas flow rate (orange) tend to correlate with rapid drops in atmospheric pressure (blue).

Figure 8.2 – Graph Comparing Atmospheric Pressure with Gas Flow Rate in Borehole RO101 (S)



It does not appear that groundwater (or landfill leachate) level is an influencing factor on ground gas flow rate. This is true in situations where the groundwater is tidally influenced (RO105 (S) and RO106 (S)) and where it does not appear to be tidally influenced (RO101 (S) to RO104 (S)). As shown on the example graphs below (Figures 6 and 7), there does not appear to be an obvious correlation between gas flow rate (orange) and water level (blue).

Figure 8.3 - Graph Comparing Gas Flow Rate and Water Level in RO103 (Non-Tidal)

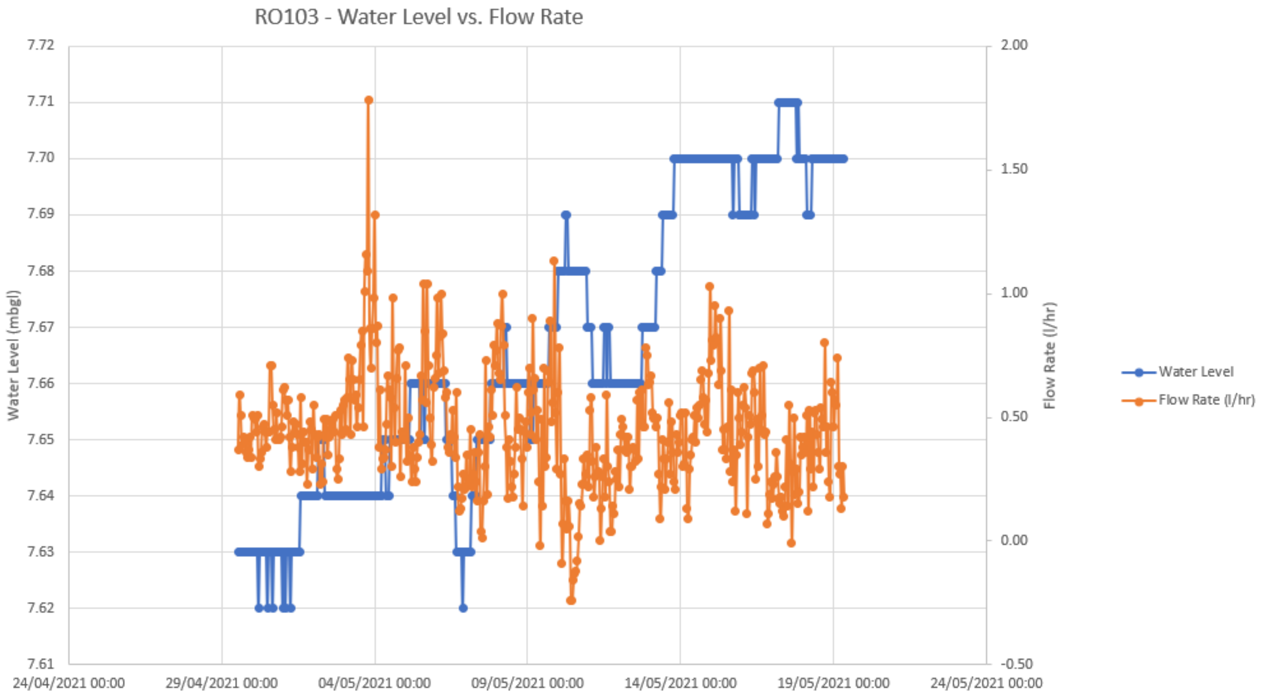
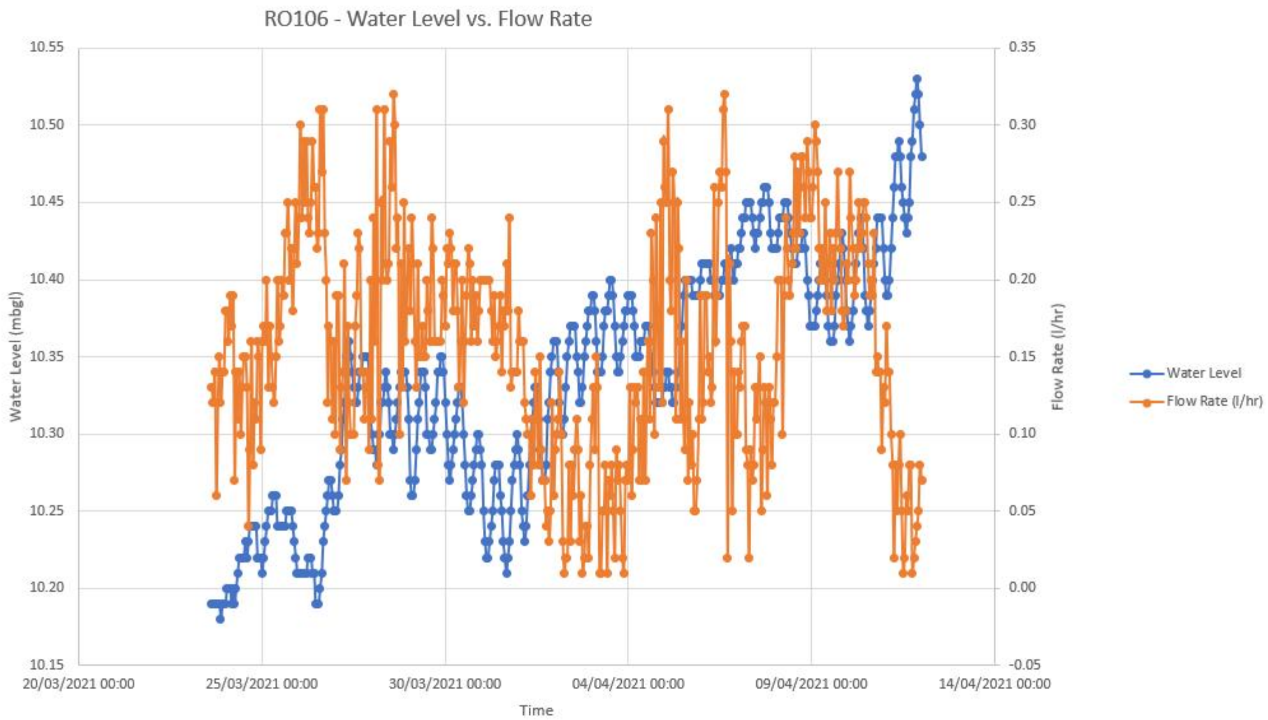


Figure 8.4 - Graph Comparing Gas Flow Rate and Water Level in RO106 (Tidal)



Continuous Monitoring – Calculation of Gas Screening Values

Using the procedure for classifying gassing sites proposed by BS 8485:2015 + A1:2019, Gas Screening Values (GSVs) have been calculated for both carbon dioxide and methane for each of the individual continuous monitoring readings.

Table 8.7 shows the number of readings in each continuous monitoring dataset, the number of readings within each Characteristic Situation bracket and the percentage of the total readings that each bracket represents.

Table 8.7 - Summary of Continuous Monitoring Dataset

Borehole	# of Readings	CS1 Readings		CS2 Readings		CS3 Readings		% of Dataset Equal to CS1		% of Dataset Equal to CS2		% of Dataset Equal to CS3	
		CH_4	CO_2	CH_4	CO_2	CH_4	CH_4	CO_2	CO_2	CH_4	CO_2	CH_4	CO_2
RO101 (S)	478	146	250	332	228	0	0	31	52	69	48	0	0
RO102 (S)	475	58	99	343	376	71	0	12.5	21	75.5	79	15	0
RO103 (S)	476	26	114	447	362	3	0	5.5	24	94	76	1	0
RO104 (S)	356	356	356	0	0	0	0	100	100	0	0	0	0
RO105 (S)	449	448	449	1	0	0	0	99.8	100	0.2	0	0	0
RO106 (S)	CH_4 = 293 CO_2 = 433	149	433	144	0	0	0	51	100	49	0	0	0

Where CS1 conditions have been recorded, this is typically due to the negligible flow rates. A review of the actual gas concentrations indicates that the concentrations are consistently above (typically by between 10 to 40 percentage points) the threshold concentrations for CS1 as suggested by Table 2 of BS 8485, and on this basis, it is considered appropriate to increase all calculated CS1 conditions to CS2.

CS3 conditions were recorded only within boreholes RO102 and RO103, with 71 of the 475 and 3 of the 476 readings respectively being equivalent to CS3 conditions.

Characteristic Situation – Summary

The assessment undertaken on the spot monitoring and continuous monitoring results shows whilst both boreholes typically exhibit CS2 conditions, CS3 conditions have been recorded in four boreholes, and within one of these borehole CS3 conditions were prevalent for approximately 15% of the monitoring period.

It is considered that a classification of CS3 is appropriate and suitably (but not overly) precautionary.

8.3 Possible Gas Protection Measures

The proposed buildings at the site are considered to be of "Type C" as described in Table 3 of BS 8485. "Type C" buildings are under commercial/public ownership, where there is full control over the change of use / structural alterations / ventilation of the structures, and where internal rooms are small to large.

Table 4 of BS 8485 shows that "Type C" buildings on a site with a classification of CS3 need to include gas protection measures to achieve a minimum score of 3.0.

When the minimum gas protection score has been determined for the building as a whole, or for each part of the building, then a combination of two or more of the following three types of protection measures should be used to achieve that score:

- The structural barrier of the floor slab, or of the basement slab and walls if a basement is present.
- Ventilation measures.
- Gas resistant membrane.

It is recommended that a specialist gas protection measures designer is engaged to provide a design for the landfill gas protection measures.

9 Generic Quantitative Risk Assessment (GQRA) - Summary

9.1 Potential Hazards to Human Health

In the cover soils, the identified human health hazards in the solid phase are limited to asbestos which was visually identified in one exploratory hole and detected by the laboratory in 2 out of 33 samples, and marginally elevated (vs. the GAC for a commercial / industrial end use) concentrations of benzo(a)pyrene and dibenzo(a,h)anthracene which were recorded in one sample of the cover soils only.

In the waste mass, the identified human health hazards in the solid phase are principally limited to asbestos which was detected by the laboratory in 14 of the 50 samples analysed. Concentrations of metals, petroleum hydrocarbons, BTEX, VOCs and SVOCs were below the adopted GAC in all samples. Concentrations of PAHs were below the adopted GAC in all samples with the exception of BHW001 at 2.1 m bgl which recorded concentrations of dibenzo(a,h)anthracene in excess of the GAC[15].

There were no exceedances of the commercial/industrial GAC within the natural soils.

The ground gas risk assessment undertaken on the landfill gas spot monitoring and continuous monitoring results shows whilst the boreholes typically exhibit CS2 conditions, CS3 conditions have been recorded in four boreholes, and within one of these borehole CS3 conditions were prevalent for approximately 15% of the monitoring period. It is considered that a classification of CS3 is appropriate and suitably (but not overly) precautionary.

Mitigation measures will be required to mitigate the identified asbestos and PAH hazards to human health within the cover soils and landfill waste. Ground gas protection measures will be required in the construction of any proposed enclosed buildings. The proposed mitigation measures are detailed in the Outline Remediation Strategy in **Section 11**.

9.2 Potential Hazards to Controlled Waters (including Aquatic Ecology)

The elevated concentrations (vs. the saltwater EQS) of metals (copper, nickel, lead and zinc, as well as a single elevated concentration of mercury) and ammoniacal nitrogen identified in the groundwater within the shallow superficial deposits and the chalk and the elevated concentrations of ammoniacal nitrogen, copper and zinc identified in the surface waters within the Hermitage Stream present a potential hazard to aquatic

[15] The sample recovered from BHW001 at 2.1 m recorded a dibenzo(a,h)anthracene concentration of 8.53 mg/kg, equal to this sample's method detection limit which is well in excess of the limit for other similar samples. A review of the laboratory's report for this sample indicates that "*a non-standard volume or mass has been used for this test which has resulted in a raised detection limit*". On this basis, it is considered that the 8.53 mg/kg concentration recorded in this sample is a 'true' detection, and this sample should be disregarded.

ecology within both the groundwater, surface water and within the adjacent Langstone Harbour SSSI, SPA, SAC etc.

It is noted that these concentrations are compared to the saltwater EQS without an adjustment for bioaccessibility.

Ammonia concentrations are significantly elevated in the waste mass and also highly elevated within the groundwater recovered from both the chalk and the superficial deposits. The surface water within the Hermitage Stream appears to be slightly impacted with ammonia and it is suggested that leachate from the Site and the other 'dilute and disperse' type landfills within the reclaimed land is entering these waters. It is also possible that an off-site source of copper is present upgradient of the Site. It should be noted that release of leachate to the surrounding environment is the expected behaviour for an un-lined 'dilute and disperse' type landfill.

Elevated concentrations of certain PAHs have been recorded within the waters recovered from boreholes screened within the waste mass. Groundwater within the underlying River Terrace Deposits / Raised Marine Deposits Secondary A Aquifer appears to be marginally impacted by PAHs, with two of the twelve samples analysed recording elevated concentrations. One of the 38 samples of groundwater from the chalk recorded a single marginally elevated PAH concentration, suggesting that groundwater within the Principal Aquifer is not significantly impacted by PAHs.

Mitigation against the release of leachate from the landfill would require either the removal of the source (i.e., the landfill waste) from the Site, or the temporary removal of all the landfill waste followed by the installation of a landfill liner, and the replacement of the waste. This is neither sustainable or economically viable, and both could result in the release of a significant volume of landfill leachate leading to significant harm of the surrounding water environment. Measures to mitigate against any additional risks introduced through the development of the Site can however be undertaken, and these are detailed in the Outline Remediation Strategy presented in **Section 11**.

10 Outline Remediation Options Appraisal

10.1 Introduction

The purpose of this Section is to outline the general principles for reducing the potential risks to the specific receptors from the hazards identified. It should be noted that changes to the design and layout of the development could affect the approaches in the outline remedial strategy.

The Site comprises a restored landfill, with wastes placed directly onto the natural underlying soils and retained (above the former marshland level) by a bund wall. The landfill within the Site is only one of several present within the wider area of reclaimed land used for landfilling.

The Site has been subjected to three separate phases of intrusive investigation which have revealed both impacted ground and groundwater beneath the Site – this is not unexpected given the Site's historical use and, in the case of groundwater, is 'by design' given the 'dilute and disperse' type of the landfill.

On the basis of the data review and generic quantitative risk assessments presented in the sections above, the following hazards have been identified for the plausible receptors:

- Human Health (Construction Phase) – Asbestos, PAHs, landfill gases, unexpected contamination including known and potential hazards such as metals, TPHs, PAHs, asbestos, VOCs, SVOCs, PFAS etc. via dermal contact, ingestion and inhalation (indoor and outdoor) of dusts, soil particles and landfill gases.
- Human Health (Operational Phase) – Asbestos, PAHs via dermal contact, ingestion and inhalation (indoor and outdoor) of dusts, soil particles and landfill gases, ingestion of contaminated drinking water due to permeation by organics into water supply pipe.
- Controlled Waters – Groundwater (Construction and Operational Phase) – Metals (copper, nickel, lead, zinc), mercury, ammonia, PAHs
- Controlled Waters – Surface Water (Construction Phase and Operational Phase) – Metals (copper, nickel, lead, zinc), ammonia
- Ecologically Sensitive Sites – Metals (copper, nickel, lead, zinc), ammonia
- Buildings/Construction Materials – Ground conditions aggressive to concrete and plastics may be present.

10.2 Embedded Mitigation

The following actions provide mitigation against the identified hazards either as a result of already existing conditions, or as a consequence of their construction as part of the Proposed Development.

- The construction of new areas of built development and hardstanding will create a barrier, breaking the direct contact and inhalation human health exposure pathways in the completed development.
- The construction of the Proposed Development is likely to provide betterment through a reduction in infiltration through the cover soils of the landfill via the introduction of new areas of impermeable development. Infiltration drainage is not proposed. A reduction in infiltration will correspond to a reduction in leachate generation and therefore a corresponding reduction in contaminant load being released to controlled waters.
- The piled foundations and shafts will be designed to accommodate downdrag from negative skin friction and will be founded below the landfill, this will mitigate against risk of failure/breach and leakages.
- The construction of the piled foundations, tunnels and shafts must adhere to technical requirements/standards which ensure quality, e.g., requirements for watertightness of the diaphragm

walls and a gasket system in segmentally lined tunnels, as well as annulus grouting, with all completed structures inspected on completion. This mitigates against the risk of faults or installation errors giving rise to failures/breaches and leakage.

- The risks associated with general leakages are mitigated as follows. Sumps are located within the shafts to collect leaked water and transmit it to the surface. Tunnels are constructed at a gradient leading to wards the shaft. Shafts are accessible for maintenance / repair works.
- The Proposed Development is designed in such a way that promotes mitigation of environmental risks during construction, e.g.:
  - The landfill either side of the diaphragm wall excavation trench will be stabilised by support fluid and deep soil mixing, prior to casting the diaphragm wall, limiting potential for trench instability and promoting a 'clean' interface between the wall and the surrounding ground and the reduction in creation of preferential pathways.
  - The shaft secondary lining provides a watertight seal around the shaft, limiting the ingress of gases, and minimising the potential for the shafts to act as a pathway for migration of gases. The majority of the tunnels are to be constructed below the groundwater which also minimises the possibility of gas migration into the tunnels, and for the tunnels to act as a pathway for migration of gases.
  - Pressure control at the tunnel face will limit excess fluids being pushed into surrounding ground and tail-skin grouting to prevent flow path formation along outside of tunnel. Thixotropic grout will be injected around the annulus to provide intimate contact between the tunnels and shafts. This grout sets quickly to prevent wide dispersal into ground.
  - Use of CFA piles to promote intimate contact between piles and surrounding soils.

Following the grant of planning permission in 1968 it appears that a sheet pile wall was added to the design of the bund wall that retains the landfills within and adjacent to the Site, below the seaward face. Details of the length of the sheet-piles are unclear and appear to vary along different points in the bund, with various lengths of between approximately 1.8 m to 6.0 m (Drawing 639/92, **Appendix B**). The bund is indicated to be constructed of "chalk fill" (drawing 639/87, **Appendix B**). Depending upon the depth the sheet piled wall is constructed to, the wall may provide an element of 'cut off', preventing lateral migration of landfill leachate through the more permeable near-surface soils and into the Hermitage Stream and Langstone Harbour.

10.3 Options Appraisal

The options appraisal stage of risk management comprises the following three steps:

- Identify feasible remediation options.
- Do a detailed evaluation of options.
- Select the final remediation option.

Before identifying options, the technical and management objectives to be achieved are defined below.

Project Development Objectives

The technical objectives are to construct a new water recycling plant at the Site. The majority of the process plant and tanks will be located within the western half of the Site, with more lightly loaded structures located in the east.

Management Objectives

It is anticipated that the remediation outcomes would achieve the following:

- Secure regulator agreement and approval of a Development Consent Order.
- Avoid unacceptable environmental impacts, health and safety issues and minimise long term liabilities.
- Avoid the requirement for long term monitoring or maintenance.
- Meet timescales and budgets.

Remediation Objectives

The Remediation Objective is to break the identified contaminant linkages, with the options for risk management comprising one or more of the following:

Option 1 Treatment of the source – remediation of soil and/or groundwater to decrease contaminant mass, concentration, mobility or toxicity and/or remove the source.

Option 2 Manipulation of the pathway such as containment of the contaminant.

Option 3 Management of the receptor and /or exposure pathway.

We have considered the relative ability of each option to achieve the remedial objective in a safe and timely manner whilst optimising the environmental, social and economic value of the work.

Option 1 is not considered to be viable because mitigation against the release of leachate from the landfill would require either the removal of the source (i.e., the landfill waste) from the Site, or the temporary removal of all the landfill waste followed by the installation of a landfill liner, and the replacement of the waste. This is neither sustainable or economically viable, and both could result in the release of a significant volume of landfill leachate leading to significant harm of the surrounding water environment.

Options 2 and 3 have been retained for further consideration and the contaminant linkages requiring management via these Options are summarised in Table 10.1.

Table 10.1 Summary of Contaminant Linkages Requiring Risk Management

Contaminant Linkage (CL)	Hazard	Receptor & Pathway	Risk Reduction Measures
CL1	Cover soils and landfill waste – Asbestos, PAHs, Landfill Gases	Construction workers, workers at adjacent commercial development, members of the public using the footpath adjacent to the Hermitage Stream / nearby green spaces - Inhalation	Placement of a piling mat at the prepared formation level (pathway break). Compliance with Health & Safety legislation Preparation of a Construction Environmental Management Plan Watching brief and discovery strategy in place during groundworks. Landfill gas protection measures

Contaminant Linkage (CL)	Hazard	Receptor & Pathway	Risk Reduction Measures
CL2	Unforeseen Ground Conditions	Construction workers & Neighbouring - All	Compliance with Health & Safety legislation Preparation of a CEMP Preparation of a Watching Brief and Discovery Strategy
CL3	Made Ground – Asbestos, PAHs.	Future Maintenance/Service workers - All	Service trenches to be lined with a marker geotextile and backfilled with clean, imported aggregate around services. Compliance with Health & Safety legislation.
CL4	Made Ground – Asbestos, PAHs, Landfill gases	Future Users – All	Watching brief and discovery strategy implemented during construction of any landscaping. Any proposed areas of soft landscaping should include a clean cover system. The presence of the cover system and marker membrane should be recorded in the completed development's Health and Safety file. Compliance with Health & Safety legislation. Landfill gas protection measures.
CL5	Made Ground - Hydrocarbons	Future Users Permeation of Water Supply Pipe	Design - provision of barrier pipe if unexpected hydrocarbon contamination is encountered. Watching Brief and Discovery Strategy
CL6	Made Ground – aggressive ground conditions	Concrete Direct Contact	Design – appropriate specification of concrete mix and selection of appropriate in-ground materials
CL7	Metals, ammonia	Controlled Waters & Ecologically Sensitive Sites – Migration via natural and anthropogenic routes, direct recharge	CEMP which would be supported by the following: – Surface Water Management Plan, Water quality monitoring requirements – Definition of control measures should the agreed threshold concentrations be exceeded – Foundation Works Risk Assessment

Contaminant Linkage (CL)	Hazard	Receptor & Pathway	Risk Reduction Measures
			– Selection of appropriate piling and shaft/tunnel construction methodology.

11 Outline Remediation Strategy

11.1 Health & Safety Legislation - Contaminant Linkages 1, 2, 3 and 4

The Construction (Design & Management) Regulations (CDM 2015) are the main regulations for managing the health, safety and welfare on construction projects and will apply to the Proposed Development. A Principal Designer (PD) and Principal Contractor will be appointed by the client to plan, manage, monitor and coordinate health and safety during the pre-construction and construction phases respectively. The PD role includes identifying, eliminating or controlling foreseeable risks.

All persons engaged in earthworks and construction will be made aware of the findings of the intrusive ground investigation and the potential for contamination to be present. A Site-specific health and safety plan will be produced in accordance with CDM 2015 Regulations.

The Principal Contractor (PC) will have responsibility for ensuring legislative compliance and obtaining all permits/licenses as required. The following are highlighted but should not be considered the only aspects to be addressed.

It will be the responsibility of the Principal Contractor to ensure that a safe working system is in place including measures to manage the presence of asbestos identified on Site.

The Control of Asbestos Regulations (CAR), 2012 require that where there is a potential for asbestos containing materials (ACMs) including soils to be disturbed, an assessment of risk is required. The person undertaking the Risk Assessment must be competent to do so in line with Regulation 10.

The Principal Contractor will be responsible for the provision of an appropriate risk assessment, in line with Regulation 6, which must include the following:

- Description of work including type and duration.
- Type, quantity and condition of ACMs.
- Steps to reduce exposure to the lowest level reasonably practicable including detail of how stockpiles will be conditioned/ managed to prohibit dust migration during periods of high wind.
- The reasons for the chosen work methods; Steps taken to control the release of asbestos into the environment.
- Details of expected exposure and number of people affected.
- Details on the type and use of Respiratory Protective Equipment (RPE) and Personal Protective Equipment (PPE).
- Details of decontamination procedures.
- Procedures for waste removal.
- How to deal with emergencies.
- Other information relating to safe working.

11.2 Construction Environmental Management Plan – Contaminant Linkages 1, 2 and 7

The purpose of a Construction Environmental Management Plan (CEMP) is to outline how a construction project will avoid, minimise, or mitigate effects on the environment and surrounding area. The CEMP will present / be informed by:

- Environmental requirements and controls to cover policy and planning, environmental impacts, risks and mitigation, procedures for monitoring construction processes against environmental objectives, pollution control measures, environmental risk register.
- Consents, commitments, and permissions considering all appropriate environmental legislation, planning conditions and any other consents or licensing.
- An asbestos management plan detailing the measures to be adopted during the construction phase for the control of asbestos hazards, and the procedures/protocols to be followed in the event of unexpected asbestos contamination being encountered.
- Good practice principles for the protection of construction workers' health, such as promotion of good hygiene, health monitoring, provision of appropriate PPE, limiting proximity between construction workers and testing of landfill waste pending removal from Site, etc.
- A dust management plan. This plan will include measures to be adopted during the construction phase for the control of any dust that might emanate from the development site and will be in accordance with the guidance as laid out BRE Report 465 – Control of Dust from Construction and Demolition Activities. Such measures could include the use of dust suppression systems, keeping of haul roads (and areas where construction plant regularly track over) damp during dry weather conditions and the use of wheel washes to prevent mud being tracked onto the adjacent highway.
- A surface water management plan. This plan will include the measures to be adopted during the construction phase and will describe measures to prevent overland runoff from construction/stripped areas reaching surface waters, or surface water drains (including highway drains), e.g., the use of French drains, ditching, planting of filter strips, silt fencing etc. Provisions will account for site topography, existing surface-water drainage, planned service installation, and planned groundworks / processing.
- The findings of investigation / survey to determine the presence / condition of any existing drainage that crosses the Site. DWG 639.84 (**Appendix B**) records a potential drainage run between the "*12" diameter porous pipe*" within the drainage ditch on the Site's northern boundary, which links to a manhole (MH5) before crossing the Site's north-eastern corner to an outfall to the Hermitage Stream. Where the condition of this drainage is such that it could represent a potential pathway for contaminant migration, e.g., through settlement induced damage causing a breach in integrity of the conduit, repairs should be undertaken. Sampling of the water conveyed by the drain, at the outfall to the Hermitage Stream could also be undertaken to determine whether the water within the drain exhibits any of the characteristics of landfill leachate.
- A vibration management plan. This plan will include measures for ground-borne vibration control as per BS5228:2009+A1:2014 Part 2: Vibration.
- Environmental controls to be enacted during construction to limit leachate generation. Such measures could include the pumping out of excavations during inclement weather (and the capture and treatment of the waters removed), management of construction to limit the number of open excavations wherever possible, or the covering of open excavations (where possible) during site down-time e.g., weekends, when inclement weather is forecast.

The CEMP will contain measures to minimise the potential for generating contamination during construction phase likely to include, but not limited to, the following:

- The provision of spill kits and appropriate training of all Site personnel.
- The specification of dust minimisation measures to be implemented.

- The siting of chemicals, fuel and oil stores on impervious hardstanding and within bunded areas at a location away from surface water bodies.
- A requirement for standing machinery to have drip trays placed underneath to prevent oil or fuel leaks causing pollution.
- A requirement for the refuelling of vehicles and machinery to be carried out in one designated area with spill kits located close by in the event of a spill on an impermeable surface a suitable distance away from surface water bodies.
- A prohibition on the burning of any materials on-Site.
- Protocol for soil re-use.
- A Discovery Strategy including a requirement for a geo-environmental watching brief for contamination during in-ground works.

11.3 Discovery Strategy (Unexpected Ground Conditions) – Contaminant Linkages 1, 2, 4 and 5

A discovery strategy will be written that defines how any unusual materials (solids, liquids or gases/odours) will be managed if encountered during the construction works. The strategy awareness establishes protocols to be implemented (and by whom) and will include the following:

- All personnel working on site will undergo a site induction and toolbox talks which will include references to potential environmental hazards such as contamination.
- Training and Maintaining Awareness Programme – mechanisms such as posters or monthly repeat inductions to reinforce the procedure and highlighting the key steps to be followed should contamination be identified.
- Watching Brief – including competent person definition
- Communication protocol.
- Assignment of a Specialist Contamination Advisor.

11.4 Service Trenches – Contaminant Linkage 3

To mitigate the hazard to future maintenance / service workers associated with the inhalation/ingestion/contact with contamination in the Made Ground the following will be undertaken.

- Remove all Made Ground from within the trenches and replace with “clean” imported material.
- Incorporate a marker membrane within all service trenches to identify the presence of potentially asbestos contaminated Made Ground below.

Any imported soil for any purpose will conform to an importation criteria specification.

11.5 Aggressive Ground Conditions – Contaminant Linkages 5 and 6

The identification of risks to the development associated with ground conditions by the PD and implementation by the PC will be informed by the available reports.

Water supply pipes will be specified to address the Site-specific ground conditions.

The design of the Proposed Development will incorporate specification of construction materials to mitigate aggressive ground conditions. The guidance (BRE, 2005) should be followed in the design of mixes for buried concrete for the classifications given.

11.6 Landfill Gas Protection Measures – Contaminant Linkages 1 and 4

During the construction phase, it will be necessary to provide landfill gas protection measures to all temporary structures at the Site. This includes offices, stores, drying rooms, welfare facilities etc. It is envisaged that this will be most readily accomplished by placing such structures on blocks to raise them above ground level and provide a ventilated void, allowing any gases migrating upwards from the landfill to vent to the atmosphere rather than to collect within enclosed spaces. Other measures that could be considered by the Principal Contractor, where required, include:

- Regular gas monitoring / fitting of sensors to structures.
- Provision of personal gas monitors.

The proposed buildings at the site are considered to be of "Type C" i.e., are under commercial/public ownership, where there is full control over the change of use / structural alterations / ventilation of the structures, and where internal rooms are small to large. Any buildings containing fully enclosed rooms constructed as part of the Proposed Development should be constructed with gas protection measures sufficient for a site categorised as Characteristic Situation 3 and could comprise:

- The structural barrier of the floor slab, or of the basement slab and walls if a basement is present.
- Ventilation measures.
- Gas resistant membrane.

It is recommended that a specialist gas protection measures designer is engaged to provide a design for the landfill gas protection measures. The recommendations of the gas protection measures designer should be followed, and a verification report demonstrating the correct installation of the protection measures should be prepared and signed off by the Local Planning Authority.

If / where ventilation and passive venting options are considered, these measures must be designed to ensure that they do not compromise the overarching objective of reducing infiltration, e.g., if venting trenches are to be used, these should be capped with impermeable material and fitted with a gas collection system to convey the migrating gases to cowled vent stacks.

Whilst permeable paving would provide venting for landfill gases it is not compatible with the expectation of a reduction in infiltration and will only be used in areas where an underlying collection/attenuation system is proposed.

11.7 Clean Cover System – Contaminant Linkage 4

To mitigate the hazard to end-users associated with the inhalation of asbestos and PAHs in the Made Ground the following will be adopted.

All proposed areas of soft landscaping will be capped with a "clean cover" system comprising a marker membrane overlain by 600mm thickness of "clean" imported subsoil and topsoil. It is considered that a 600mm thickness will provide sufficient mitigation against the disturbance through regular landscaping activities, (e.g., shrub planting etc.) of the underlying Made Ground though care should be taken to ensure that the rooting depths of the selected plants will not exceed the cover system thickness. The presence of the clean cover system incl. marker membrane should be recorded in the completed development's Health and Safety file.

Any imported soil for any purpose will conform to an importation criteria specification.

It is noted that on the basis of the commercial/industrial land use at the site, existing vegetated areas that are not proposed to be excavated during the development and are not to be used in new areas of soft landscaping are not anticipated to require a clean cover system. The potential presence within the near-surface soils should be recorded in the completed development's Health and Safety file.

11.8 Selection of Piling and Shaft/Tunnel Construction Methodology – Contaminant Linkage 7

It is anticipated that Continuous Flight Auger (CFA) piles will be utilised as this method allows for intimate contact between the cast-in-place pile and the surrounding landfill waste, reducing the potential for the creation of additional pathways by which contamination could migrate into the underlying aquifers and laterally into adjacent surface waters.

An Outline Foundation Works Risk Assessment for the piling and shaft construction works within the WRP site has been prepared (SSP, 2024) and will support the Outline CEMP. The Outline FWRA should be read in conjunction with this Outline Remediation Strategy. Post-consent, following the development of the detailed design of the proposals, the Outline Foundation Works Risk Assessment will be updated to support the final CEMP.

The purpose of the Outline FWRA is to ensure that the proposed foundation method will not have an adverse impact by creating new pathways for the migration of contamination, considering the protection of both water resources and human health.

The Outline FWRA identifies that: "*with appropriate selection of piling techniques and associated control measures the potential risks associated with the construction of the proposed piled foundations are considered to be **Low** to **Moderate***" and that: "*with appropriate selection of shaft construction techniques and associated control measures, the potential risks associated with the construction of the proposed shafts are considered to be **Very Low** to **Moderate***". The Outline FWRA further notes that "*the landfill beneath (and to the south and west of) the Site operates on the 'dilute and disperse' principle, where migration of leachate out of the landfill into the surrounding groundwater is the expected behaviour. On this basis, **Moderate** risks are not considered to represent an increased risk relative to the existing scenario (i.e., negligible impact beyond the existing scenario)*".

The Outline FWRA suggests the following mitigation measures for the piled foundations:

- *"Design of piles to try to minimise penetration into the chalk e.g. by considering larger pile groups with shorter piles.*
- *Placement of concrete at a rate consistent with the withdrawal of the auger to ensure support of the soil during CFA piling.*
- *A risk assessment in accordance with BRE Special Digest 1:2005 conducted at detailed design stage in order to verify the concrete class. This will ensure that the risks of pile degradation will be negligible.*
- *Design of the concrete mix for the piles to limit bleeding into pore spaces".*

The Outline FWRA suggests the following mitigation measures for the Proposed Development:

- *"Design of shafts to try to minimise penetration into the chalk by tailoring to local ground conditions.*
- *Cut off walls to be designed to optimise stability of the diaphragm wall trench by tailoring to local ground conditions.*

- *Design of the concrete mix for the diaphragm walls to limit bleeding into pore spaces.*
- *Design of grout and fissure grouting methodology to limit excess dispersal through the Chalk.*
- *Appropriate selection of additives and conditioning agents for construction and the exclusion of hazardous substances. EA to be consulted on requirement for JAGDAG assessment where appropriate.*
- *A risk assessment in accordance with BRE Special Digest 1:2005 conducted at detailed design state in order to verify the concrete class. This will ensure that the risks of shaft degradation will be negligible.*
- *A Groundwater Monitoring Plan to identify significant changes in groundwater levels/ contamination levels in key locations during construction, and a Contingency Action Plan (CAP) established.*
- *A break out management plan (to be prepared by the Contractor) to mitigate and remediate any bentonite break outs that could occur during the works.*
- *Appropriate storage/ treatment of potentially contaminated water pumped out during dewatering to inhibit contamination of ground or surface water bodies".*

11.9 Other Actions - Soil Excavation, Re-Use and Disposal Protocol

The Contractor will prepare a procedure for identifying where waste will be generated, any additional testing to confirm the classification and measures to be adopted to address the requirements of the European Waste Directive that all waste needs to be pre-treated prior to disposal.

If material is proposed to be removed or re-used off-Site or reused on-Site as part of the works, it will require appropriate classification and / or sorting to demonstrate suitability. The actual material to be excavated should be analysed and assessed as suitable for reuse by assessing potential risk to human and controlled water receptors.

There should also be a clear requirement for reuse in the scheme design and may require consideration as part of a materials management plan or U1 exemption. It is the Contractor's responsibility to appropriately classify material excavated and ensure adequate testing is completed.

It is the position of the Environment Agency that re-use of soils within an historical landfill is outside of the scope of the Definition of Waste: Development Industry Code of Practice (CL:AIRE, 2011). It will therefore not be possible to use this protocol to manage the movement and re-use of soils on-Site.

Off-Site disposal requires an accurate written description of the waste and must include:

- The waste classification code, also referred to as LoW (List of Waste) or EWC (European Waste Catalogue) code - classification codes for common types of waste are in the relevant parts of this guidance.
- Whether it's hazardous or Persistent organic pollutant (POPs) waste.
- The type of premises or business where the waste was produced.
- The name of the substance or substances.
- The process that produced the waste.
- A chemical and physical analysis of the waste and its components.
- Any special problems, requirements or knowledge related to the waste.

For controlled waste that is classified as 'non-hazardous' this will be a waste transfer note and for waste classified as 'hazardous' this will be a consignment note. In both cases the record will require a waste code and classification.

Failure to comply with the duty of care requirements is a criminal offence and could lead to prosecution.

Dewatering of Excavations

If dewatering[16] is required, abstraction and discharge licences will be sought from the Environment Agency under the terms of the Environmental Permitting Regulations 2010. On the basis that any waters pumped from excavations may be contaminated with landfill leachate, infiltration of the waters or disposal to surface water will not be possible without treatment. Discharge to sewer may be possible subject to the utility provider approval. It should be noted that if free product is present then separation prior to discharge to sewer might be necessary.

[16] Dewatering as stated here does not include the short term, temporary discharge of uncontaminated water (wholly or mainly rainwater) from an excavation to surface water, as covered by EA Regulatory Position Statement 261. Noting that this would not be applicable to excavations within the landfill waste mass.

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